User Manual

Servoconverter ND 31

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Lenord, Bauer & Co. GmbH
Dohlenstraße 32
D-46145 Oberhausen

Tel. +49/208/9963-0
Fax +49/208/676292
E-Mail: info@lenord.de
Internet: http://www.lenord.de

...automates motion

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1. General

1.1 About this Documentation

The documentation for your EcoServ ND31 consists of 3 components:

- (This) User Manual

This section is for users who are project managers, deers and software developers. Here you will find the information needed for designing a system using the EcoServ.

- Set-up and Parameter Setting

This section is for developers and technicians who must perform the set-up and configuration of the ND31. It will be sent on request with ND31 delivery.

- Instructions for Installation and Replacement

These instructions are for technicians and electricians who must install or replace the ND31. This flyer will be enclosed with ND31 delivery.

The symbols below will be used in this manual. These symbols will assist you in quickly finding important information.

The commonly used danger symbol, identifies text passages that must, by all means, be read and clearly understood! Not observing these passages could endanger the life and health of yourself and others.

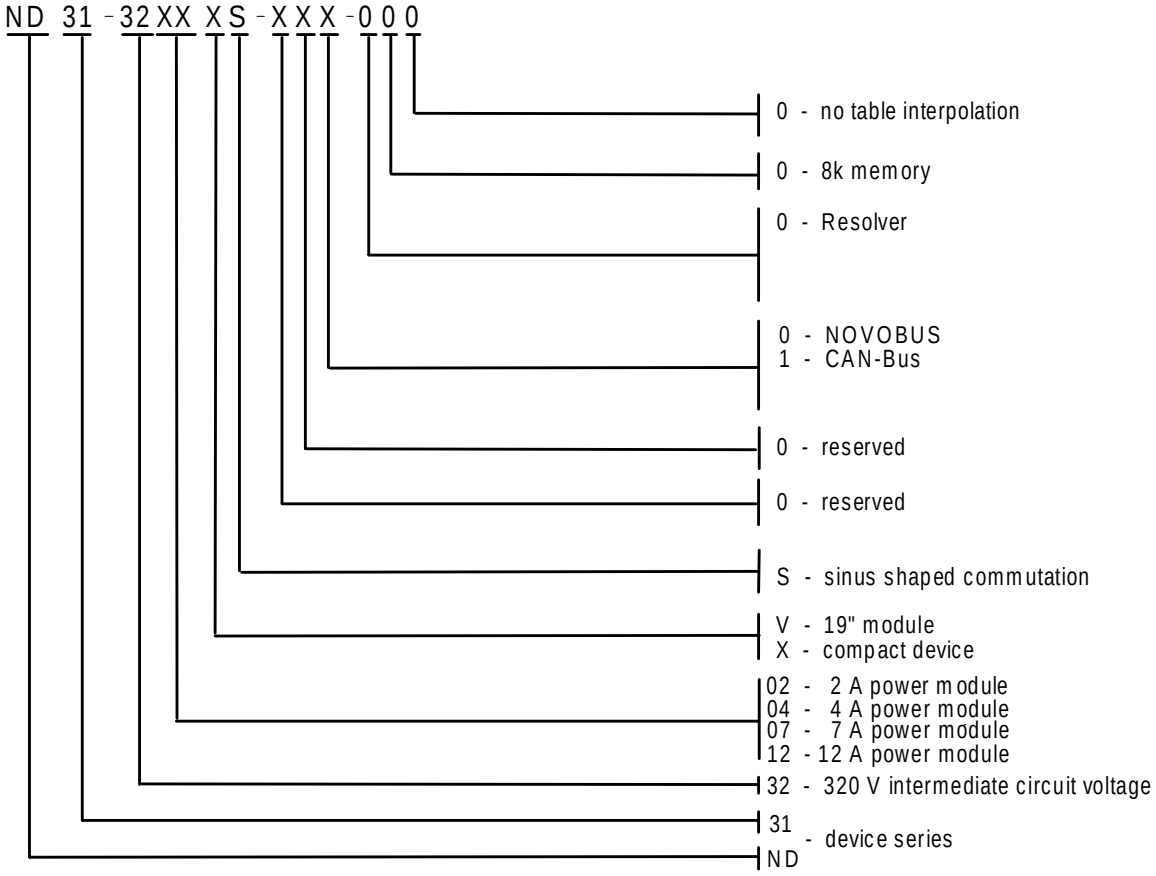
ATTENTION!

Text passages marked with "ATTENTION" must, by all means, be read and clearly understood! Ignoring these passages could lead to the destruction or damaging of the EcoServ or the machine in which it is installed.

1.2 Customer Service

Lenord, Bauer & Co. GmbH
Dohlenstraße 32
D - 46145 Oberhausen
Telefon: +49-208-9963-0
Fax +49-208-9963-201

1.3 Designation


ND 31 - 32 XX X S - X X X - 0 0 0
0 - no table interpolation
0 - 8k memory
0 - Resolver
0 - NOVOBUS
1 - CAN-Bus
0 - reserved
0 - reserved
S - sinus shaped commutation
V - 19" module
X - compact device
02 - 2 A power module
04 - 4 A power module
07 - 7 A power module
12 - 12 A power module
32 - 320 V intermediate circuit voltage
31
ND
- device series

1.4 Rights

IBM is a registered trademark of the IBM Corporation.

2. General Safety Remarks

There are operating voltages in the ND31 that can be fatal!

Wiring Therefore, check the wiring of the ND31 before switching it on. Ensure that all plugs are properly inserted and grounding has been properly performed.

Saftey Components Ensure that no voltage carrying parts can be accidentally touched and all safety components of the ND31 are present and properly connected.

Emergency Power-Off Provide an “Emergency Power Off” switch so the motor can be switched off at anytime.

Electrolytic Capacitor After power-off the electrolytic capacitor takes approximately one minute to unload! This means: One minute after power-off, fatal voltages are still present in the device. During this time period nothing is to be touched.

Voltage In case the motor continues to turn after the power supply has been switched off, the fatal voltage can be prolonged until a total stop occurs. Only then the unloading of the electrolytic capacitor begins.

On and Off Switching Avoid excessive, repeated and rapid on and off switching of the power supply, this could overload the switching current limiter of the ND31. This overloading can lead to the destruction of the limit switch limit resistance.

Order of Switching On When switching on, the power supply connection should be set first for the automatic control part before switching on the power supply. When switching off please proceed reverse.

2.1 Proper Usage

EcoServ ND31 The frequency converter EcoServ ND31 is a pulse and frequency converter for controlling brushless servo and asynchronous motors. It is a state of the art converter. Using the converter for an application other than described here, can be damaging to the health of the user or others. Also, the converter the drive or other valuable items can be damaged.

Only use the converter when error free conditions are provided. Always regard safety rules and regulations. Be aware of the manuals and abide the warnings provided.

Compatible Motors

Use only brushless servo motors and asynchronous motors with technical data compatible to the converter and its specifications.

Regulations

Install the converter only in conformance to the local specifications, standards and regulations.

Operating Environment

Do not operate the converter in areas with danger of explosions or in range of medical devices.

Exceptions: The converter is encased in a housing designed, tested and specified for operation in these applications.

2.2 Organizational Measures

Saftey Measures

As manufacturer and distributor of a machine in which this converter is used, you are responsible for ensuring that all accident prevention and safety measures have been taken.

Qualified Stuff

Ensure that installation and maintenance is only performed by a qualified electrician.

Ensure that the set-up is only performed by trained personnel. During installation, the safety warnings in this manual are to be observed.

Manuals

The designer or developer of a machine in which the converter is installed has read and understood the warnings in the manuals.

Transport and Storage

For the transport and storage of the converter the original packing has to be used.

2.3 Safety Units

Emergency Power-Off

Machines with moveable parts which are hazardous to people or the machine, must be equipped with an emergency power-off (EPO). Install the EPO as described in Chapter 6, Installation.

2.4 High Voltage

The converter works with hazardous high voltage. Read and abide to the following points.

Ensure that no parts carrying voltage can be accidentally touched.

- Install fuses as described in Section 6.2, Fuselage.
- Emergency Power-off-Installation as described in Section 6.4, Emergency Power Off Concept ND31.

- Ensure that proper grounding is provided.
- Make all connections in accordance with Chapter 5, Pinning.
- Do not disassemble the device. Do not make any changes to the device. Repairs may only be made by the manufacturer.

During set-up, abide to all safety regulations and ensure that safety features are provided.

2.5 Contact Protection Compact Device

Requirements: Protect against dangerous body current (Draft DIN VDE 160 11.94 Section 5.2.).

The following measurements are necessary to fulfill the requirements above.

- Pulling or inserting the plug of the ND31 is to be non-permissive, when the device is under voltage. Power is only to be applied to the ND31 when all connections screwed to the ND31 are protected against accidental slipping. Working on the plugs of the ND31 is not to be performed when the device is under voltage. All connection are only to be made by a qualified electrician.
- Opening the housing is not allowed!
- Before the power supply is switched on for the first time, ensure all cables have been checked to confirm proper isolation of all wires.
- This is to be repeated at each maintenance interval. Loose clamps are to be retightened. Ensure cables to moveable components, connected to the ND31, are relieved of tension.

  Protected by isolating active components (Draft DIN VDE 0160 11.94 Section 5.2.3.).

- A minimum of basic isolation protects the active components from the metal housing. The housings must be grounded! A grounding screw for this purpose is provided on the metal housing.

A wire with a diameter >= 10 mm^2 CU is required for grounding.

Periphery Plug X3

Safe isolation of all signals of the periphery plug X3 from active components is already provided in the ND31 by double isolation **(Draft DIN VDE 160 11.94 Section 5.2.18.2.).**

Resolver Plug X2

The safe isolation of all signals from the active components of the ND31 is required by double isolation.

Power Connection X1

The connection cable and wiring must have a doubled or reinforced isolating between the wires and the surface **(Draft DIN VDE 160 11.94 5.3.1.1.).**

The connection area is to be protected against accidental contact. Before the power supply is switched on, all cables are to be checked and tested for proper isolation.

Clamps for the respective wire sizes are to be used on the ends of wires.

Bus Connections X4 and X5

The signals of the bus are already separated from active components of the ND31 by double isolation. The housing of the connection cable must have a non-conducting surface.

2.6 19" Drawer Devices

Requirements: Protection against dangerous body current (Draft DIN VDE 160 Section 5.2.1.).

- Pulling or inserting the plug connections of the ND31 is non-permissive when the device is under current. Power is only to be connected to the ND31 when all plugs are protected against slipping by screwing them to the 19" frame or the ND31. Working on the plugs of the ND31 or the 19" frame is not permitted as long as the ND31 is under current. Working on the connections is only to be performed by a qualified electrician.

- The removal of the ND31 from the 19" frame is only to be performed in a power down situation and from a trained electrician. Before the ND31 is first turned on, a check is to be made for proper seating, and all cables are to be checked for proper isolation. This is to be repeated at each maintenance interval of the machine. Loosened screws are to be re-tightened.

- The connection area on the back panel of the 19" frame must be protected against accidental contact. Cables leading to movable components in the machine must be protected against being pulled out of the 19" frame.

Requirements: Protection by isolating active components (Draft DIN VDE 160 Section 5.2.3.).

- A minimum of basis isolation of the active components against the metal housing is provided. The 19” housing must be grounded. Grounding is performed by using the screw provided on the housing of the 19” drawer.
- A wire with a diameter >= 10 mm^2 CU is required for grounding.
- The 19” frame, the side post of the frame, the cover plate, the ventilator draw and the front panel are separated from the active components of the ND31 by double isolation.

Periphery plug X3

(See Section 2.5, Contact Protection Compact Device)

Resolver plug X2

(See Section 2.5)

Power plug X1

(See Section 2.5)

Bus Connection X4 and X5

(See Section 2.5)

3. Functional Description

3.1 General

Servo Converter

The ND31 is a servo converter for permanently active synchronized servo motors.

Inputs and Outputs

The ND31 is equipped with all the usual control and signal inputs and outputs such as, enable regulator, ready signal, limit switch etc.

Setting Up

Setting up the ND31 is performed with a laptop PC. The memory oscilloscope function built into the ND31 offers the possibility, to display all nominal and actual value courses of the current, torque, speed and rotor position on the laptop monitor without excessive measuring techniques.

This makes adjusting the ND31 very easy, since the effects of parameter change can immediately be evaluated. Parameters are stored in the ND31 and saved on a disc. Parameter lines can be repeatedly copied to other ND31s.

NOVOBUS

Drives can be connected with a controller via NOVOBUS. A ring-shaped wiring is required. Hardware components are not required. The transmission medium is the standarized, serial interface RS232 or RS485.

CAN-Bus

Additionally Novotron offers the CAN-Bus for ND31. CAN-Bus means a cheap solution for networking controller and ND31 and ND31 among each other.

3.2 Power Supply

Circuit Connector

ND31 is equipped with all components required for a positioning axis. This includes a power supply for directly connecting the ND31 to the 230V AC circuit. Protective switches limit the jolt of switching-on current and protect the ND31 from circuit over voltage and transients**.**

DC Circuit

The braking energy of the motor is absorbed in an intermediate DC circuit. If the capacity of the intermediate circuit condensor is insufficient, the built-in brake chopper becomes active to prevent a too high of an increase in the intermediate circuit voltage.

When inserting several ND31 it is additionally possible to couple the intermediate circuits. Therefore the energy of the brake can be devided in several intermediate capacitors. The intermediate circuit of ND31 must not be connected parallel to the intermediate circuit of other manufacturers.

When inserting several intermediate circuits of several ND31 you have to abide the same pinning of the different power connection P1, P2 and P3. Avoid exchanging the phases, this could lead to the destruction of the drive.

Ballast Switching

The internal ballast switching is checked electronically. On overloading the ballast switching stops and ND31 changes to overload.

Circuit-Breaker

A IGBT converter provides the motor with current. All motor cables are short circuit proof. All power circuits are isolated from the regulator.

3.3 Automatic Control Part

For the internal power supply of the drive a 24 VDC-power supply is necessary.

Position

The position, speed and voltage regulation as well as the pulse width modulation in the ND31 is performed digitally. The voltage regulation and the pulse width modulation are integrated in the ND31 ASIC („Potential Chip“ ND32XX), developed especially for the ND31. Another ASIC („Periphery Chip“ ND31XX) integrates a resolver converter, ROD-impulse counter, coordinates transformer and the encoder emulator.

Feedback

The remainder of the technical regulator functions are performed by a Hitachi H8/330 micro controller. ND31 needs a resolver for its feedback system in the motor or an optical signal provider.

The ND31 can also be used for analyzing multi turn resolvers. The resolver or digital conversion is performed by the periphery chip ND31XX. The resolution of the rotor position measuring is 16 bits.

Nominal Values

The following choice of possibilities are available for the nominal value input:

- Analogue +/- 10V
- Incremental encoders
- Frequency and direction impulse
- Digital nominal value input via the no cost sensor actor bus NOVOBUS (RS232/485)
- CAN-Interface

4. Technical Data

4.1 Nomenclatures

Ratings	**Over Voltage Stability**	IEC 801-4 Class 2
	Radio Interference	EN55011 Class A is upheld by using the line filter
	Isolation Concept	Double isolation between power supply and controller
	Check	Referring **VDE160 11.94 Chapter 9.1.1.**
	Protection Type	ND31 32XX **V**S IP00 (Protection Type is determined by 19“frame) ND31 32XX **X**S IP20 to DIN 40050 and IEC144
	Serial interface	RS232: ANSI/EIA232D RS485: EIA485
Signal Processing	**Modulation of the output transformer**	Digital pulse width modulator
	Modulation procedure	Modified sinus-triangle procedure
	Current regulator	Digital PI-regulator with EMK-compensation, symmetrical limiter and anti-wind-up switch
	Resolution of motor current measurement	11 bit
	Speed regulator	Digital PI-regulator with velocity advanced control and anti-wind-up switch
	Position controller	Digital P-controller with velocity advanced control
	Position relay system	Resolver or optical impulse supply
	Absolute path measuring system	Absolute resolver supports the system IMAS from the company Baumer Electric (if required). Optical multi-turn-position sensor with SSI-interface

	Motor temperature probe	Selection: Opener or PTC
Communication	**Communication protocol**	RS232/485, communication protocol: NOVOBUS
	CAN-Interface	Specification CAN2.0 part A and B ISO/DIS 11898
	Frequency/direction-interface	Entrance, RS422. Stepping motor emulation with a maximum frequency of 500kHz
	Encoder entrance	Difference inputs, RS422 standard. ROD426
	Analogue interface	±10V 14bit
		±10V 8bit
		0...5V 8 bit

4.2 Electrical Data

4.2.1 Power Supply Connection

Device type ND31-	**3202**	**3204**	**3207**	**3212**
Connecting rated voltage	230VDC	230VDC	230VDC	230VDC
Input frequency		50/60Hz		
Voltage range for connection		20 ... 240 VAC +10%		
Number of input phases		2/3		3
Connecting value for rated current	0,75kVA	1,5kVA	2,7kVA	4,5kVA

Periodical and not periodical transient over voltage:

Acceptable transient energy at the connection		10 Ws		

Half life period		1.2/50µs		
Periodical peak value		380V		
Unique peak value		2000V (on 2 Ohm)		
Max. switching current (internally limited)	160A	160A	160A	160A
Security (3phases)	3 x 4 A inert	3 x 8 A inert	3 x 14 A inert	3 x 24 A inert
(1phase)	6A inert	12A inert	15A inert	not possible
Power supply	24VDC ± 15% external, 1A			
Power consumption	24 W plus approx. 2.5 W per each controlled output			

4.2.2 Intermediate Circuit and End Amplifier

Device type ND31-	**3202**	**3204**	**3207**	**3212**
DC rail voltage with voltage connection	320 V			
Shut-off threshold with over-voltage	430 V			
Shut-off threshold with under-voltage	programmable (<30V)			
Number of output phases		3		
Output voltage		$300V_{eff}$		
Loading class		III		
Loading type		Motor load		
Intermediate circuit capacity	480	480	480	1320 µF
Power-loss in the output transformer at rated current in Watt	40	50	60	100

Remaining voltage-loss with rated current		4 V		
End amplifier tact frequency	9.76	9.76	9.76	9.76 kHz
Motor tact frequency	19.5	19.5	19.5	19.5 kHz
Rated current Tu = 25°C	2	4	7	12 A_{eff}
Peak current Tk = 25°C	4	8	14	24 A_{eff}

Maximum output current in relation to the cooler temperature:

Temp	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**°C**
3202	4	3,8	3,5	3,1	2,7	2,4	2	A_{eff}
3204	8	7,6	6,9	6,1	5,4	4,7	4	A_{eff}
3207	14	13,3	12	10,6	9,5	8,2	7	A_{eff}
3212	24	22,8	20,6	18,2	16,3	14,1	12	A_{eff}

As long as the cooler temperature remains at the given value, these currents on 3202, 3204 and 3207 are valid without time limitation. On 3212 the peak current is limited after 5 seconds.

Note: With good external venting and an environment temperature of 40°C and 7 A_{eff} motor current, the cooler reaches a temperature with ND31-3207 of approx. 75°C.

4.2.3 Ballast Switching

Continuous duty loss	Internal ballast switching	34 W (with external venting 68W)
	Internal ballast switching ND31 3204, 3207 and 3212	68 W (with external venting 130W)
	External ballast switching for ND31 3203 (2 A device)	max. 500W
	External ballast switching for ND31 3204, 3207 (2 A and 4A device)	max. 2kW
Pulse power ballast switching	ND31 3202 (2 A device)	2,5 kW

	ND31 3204, ND31 3207 (4 A and 7 A devices)	5 kW
	ND31 3212 (12 A device)	8 kW
Maximum ballast energy of the in-built ballast resistor	3202	200 Ws
	3204 u. 3207	400 Ws
	3212	600Ws
Repetition rate of the maximum ballast energy with the built-in ballast resistor		4 s
Switching threshold (Threshold automatic)		420 V
Resistance for external ballast switching	ND31 3202	50 Ohm
	ND31 3204, 3207	25 Ohm

4.2.4 Ventilation Compact Device

Ventilation	External ventilation (built-in)
Connection	Voltage connection: 230 V_{AC} Current capacity: < 200 mA
Fuselage	315 mA inert

4.2.5 Usable Connectors

Connection for power supply X1 5605,5610,5615, 5620	Phönix Combicon Front-GMSTB 2,5/16-STF
Resolver connection and motor temperature probe X2	High Density D-SUB 15pol (on the ND 21: socket contacts)
Periphery connection X3	SCSI 68 pole (on the ND31: socket contacts)
Bus output connection X4	D-SUB 9pol (on the ND31: pin contacts)
Bus input connection X5	D-SUB 9pol (on the ND31: socket contacts)

4.2.6 Resolver

Resolver: Sagem: 21RX360407, 15RX310107

Litton: JSSBH-15 E-5, JSSBH-21-P4

Siemens: V23401-H2001-B202

Tamagawa: TS2018N321 E52, TS2112N21 E11

4.3 Mechanical Data

4.3.1 Measurements

19“Module

3202, 3204, 3207	229 mm x 100 mm x 45,4 mm
3212	229 mm x 100 mm x 91 mm

4.3.2 Weight

3202, 3204, 3207	0,7 kg
3212	1,4 kg

4.3.3 Environment Conditions

Storage Temperature	**max. storage temperature**	-25°C to +70°C
	max. humidity	95 %
Operating Temperature	**Operating temperature**	0°C to 70°C
	rel. humidity	20 - 75 %
	Altitude over NN	Up to 1000 m over NN power decrease must be expected.

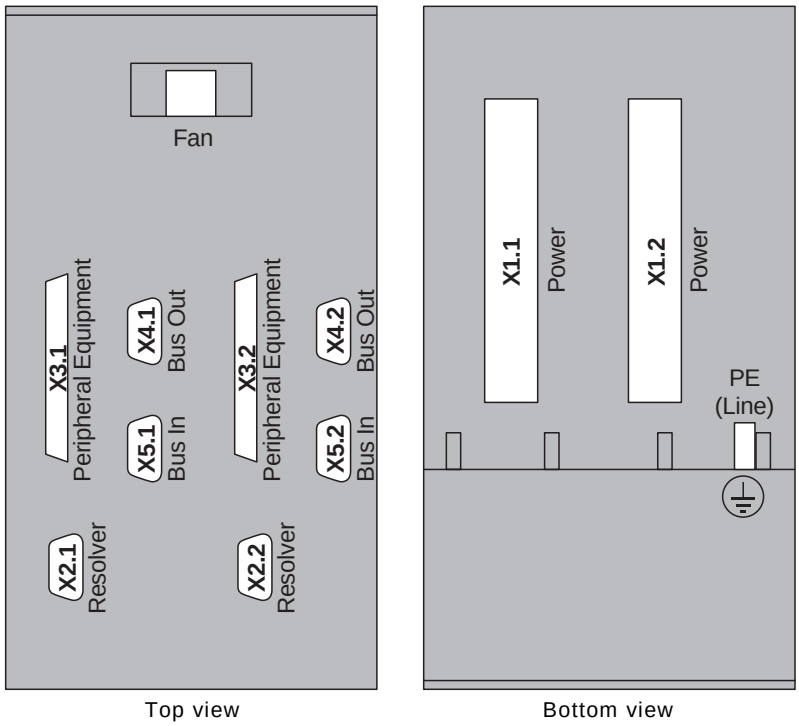
5. Pinning

High voltage! Fatal danger even in switched-off position!

As long as the motor runs, the motor is a generator!

Therefore avoid the uncontrolled drive of the EcoServ in case of interference by building in a brake.

5.1 Arrangement of the Connectors X1...X5 for two Axes



Top view Bottom view

5.2 Power Supply, Motor Connection and Brake Chopper Resistor

230 VAC maximum voltage. Higher voltage leads to the destruction of the drive.

Should the converter be used at the 400VAC-net, an appropriate transformer has to be used.

When coupling various intermediate circuits, please abide that the power connection P1, P2 and P3 have to be used equally on each ND31. If phases are exchanged could that lead to the destruction of the converter.

Plug X1 16-pole Combicon

Note: The following pinning may serve as an example. Pinning for other motors may differ from this (refer to the concerning connection table).

Pinning

	Pin		
External brake chopper resistor (option) ***)	1 eB	extBAL	
Internal brake chopper resistor ***)	2 iB	intBAL	
+ Ballast switching	3 B	+BAL	
Open	4	-	
		Transformer	One phase power supply
Power supply(max. 230 VAC)	5 E1	P1 ****)	open
Power supply (max. 230 VAC)	6 E2	P2 ****)	N
Power supply (max. 230 VAC)	7 E3	P3 ****)	L****)
- Intermediate circuit	8 –Z	-ZKS	
+ Intermediate circuit	9 +Z	+ZKS	
Motor connection	10 A3	C **)	
Motor connection	11 A2	B **)	
Motor connection	12 A1	A **)	
Ground	13 PE	PE	
Ground	14 PE	PE	
Motor temperature probe *)	15 T1	TempMot	
Motor temperature probe *)	16 T2	TempMot	

Notes:

*) If the motor temperature probe is wired with the motor cable, please connect here.

**) SBL/SBK motors refer as follows: A → U, B → V, C → W.

***) If the built-in brake chopper resistor should be used please insert a wire bridge between pins 2 and 3.

If you would like to use the external brake chopper: do not insert a wire bridge between pins 2 and 3. Connect the brake chopper resistor at pins 1 and 3.

****) The ND31 converter can be used with a max. power supply of 230VAC. If you would like to operate the converter in the 400VAC mains, please use an appropriate transformer.

Cross-Section of the Power Supply Cable

Type ND31-	**3202**	**3204**	**3207**	**3212**
Main supply 4 x	1,5	1,5	2,5	2,5mm²
Motor connection 4 x (without brake)	1,5	1,5	2,5	2,5mm²
Inner circuit-bus 2 x	1,5	1,5	2,5	2,5mm²
Brake chopper resistor 2 x	1,5	1,5	2,5	2,5mm²

All cables shielded.

Isolation

The used cables and wires must have a double or reinforced isolation between core and surface **(Draft DIN VDE 160 11.94 5.3.1.1.)**.

Fuselage

Type ND31-	**3202**	**3204**	**3207**	**3212**
3 phases (230VAC)	3 x 4 A inert	3 x 8 A inert	3 x 14A inert	3 x 24 A inert
1 phase (230VAC)	6A inert	12A inert	not possible	not possible

If several drives are to be fused together, for the whole you have to count the sum of each device.

Motor Connection

The motor has to be connected with a shielded cable on connector X1 of ND31. The cable shield has to be based on ND31 and the motor (the shield is based on both sides). On The assigned cable clamps have to be used on ND31.

The wire cross section can be interpreted according to the expected motor current. **See VDE 0113, German issue of EN 6204**:

Electric Loading

Rated cross section	0.75 mm²	1.00 mm²	1:50 mm²	2.50 mm²	4 mm²

Rated current	7.5 A_{eff}	10 A_{eff}	13 A_{eff}	18 A_{eff}	25 A_{eff}

The used cables and wires must have a double isolation between core and surface **(Draft DIN VDE 160 11.94 5.3.1.1)**.

For the cable ends cable-end-sleeves with isolation in the corresponding size have to be used.

The connection area has to be fused against accidentally touches. Before switching on the supply voltage please ensure that the fitting of all cables have been controlled and examined as well as the isolation of all cable ends.

The earthing connection has to be made on the therefore assigned earthing bolt on the housing of the compact device or on the rear wall of the 19“ rack.

Recommended motor cables: Lütze Silflex NSY, Lapp Ölflex - 400CP

Brake Chopper Resistor

The value of the external ballast switching has to be 25 ohm on ND31 3204 and 3207 and 50 ohm on ND31 3202. The external ballast switching has to be connected on plug X1, clamp 1 and 3. Cables to the external resistor have to be shielded.

The internal ballast switching is controlled electronically. When overloading the ballast switching stops and ND31 switches over to overvoltage. After switching-off the power supply and a waiting period of approximately 5 minutes the ND31 can be started again. Then the brake chopper control is again ready for operation.

The threshold value of the ballast switching is 420V DC rail voltage. The integrated automatic threshold allows to connect the parallel inner circuits of several ND31. As the ballast switching which is in action can raise its respond threshold up to 20V, it is guaranteed that the ballast energy of every connected ballast switching is divided evenly.

5.3 Resolver Connection (X2)

Danger by uncontrolled running drive!

If the resolver is not connected correctly, the drive could run uncontrolled.

Therefore please pay attention to the correct connection of the resolver when connecting a motor to the ND31.

5.3.1 Feedback System Resolver (X2)

Plug X2

Cable: Cores have to be shielded in pairs.

Note: In the following please find the pinning for Novotron motors. For divergent pinnings for other motor manufacturers see Resolver Pinning.

Solder bridge BR31, BR32, BR33, BR34 open.

Connector: 15 pole HD-DSUB – sleeve device-sided, pin contact cable-sided

Shield: Cable housing D-Sub HD.

Pinning	**Pins**			**Pinning**
		6		
Temperature probe	1		11	
		7		
Temperature probe	2		12	
		8		Rotor R1
	3		13	
		9		Stator S2
	4		14	Stator S3
		10		Stator S4
Rotor R2	5		15	Stator S1

Resolver cables have to be twisted and shielded in pairs.

Recommendation for Resolver Cables

Lütze Superflex (C)Y-PUR-Kombi Order.
No.: 111094 (usable for C-tracks, oilproof)

Lütze Electronic-LIY(C)Y-(C)Y-Kombi Order.
No.: 110652 (oilproof)

5.4 Peripheral Equipment Connection (X3)

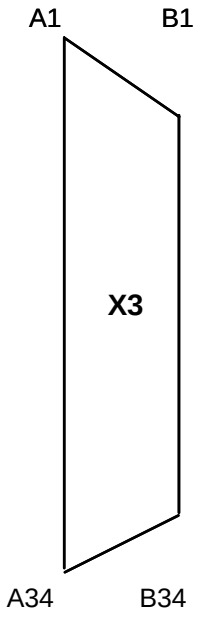
Cable

Cables corresponding to **VDE 0113 paragraph 14** are to be used for the analogue nominal value, the frequency direction standard and the encoder emulation.

Shielded cables are required.

Plug X3

68-pole SCSI2: Sleeve contacts device-sided, pin contacts device-sided.



Pinning	Pins		Pinning
+ Analogue Input	A1	B1	0V
- Analogue Input	A2	B2	5V
+ Sensor Input A	A3	B3	Analogue Output 2
Sensor Input B	A4	B4	RS
Analogue Output 1	A5	B5	R/W
Ready for Operation-Relay	A6	B6	E
Ready for Operation - Relay	A7	B7	D0
/N Encoder Emulation	A8	B8	D1
N Encoder Emulation	A9	B9	D2
/B Encoder Emulation	A10	B10	D3
B Encoder Emulation	A11	B11	D4
/A Encoder Emulation	A12	B12	D5
A Encoder Emulation	A13	B13	D6
5V	A14	B14	D7
/N Encoder Input	A15	B15	/CS
N Encoder Input	A16	B16	- Sensor Input A
B Encoder Input	A17	B17	Keyboard 2
A Encoder Input	A18	B18	Keyboard 3
/B Encoder Input	A19	B19	Keyboard 1
/A Encoder Input	A20	B20	Keyboard 4
GPIn 6	A21	B21	GPO 2
GPIn 10	A22	B22	GPO 1
GPIn 7	A23	B23	GPO 8
GPIn 2	A24	B24	GPO 3
GPIn 4 (Reference)	A25	B25	GPO 7
GPIn 5 (Release)	A26	B26	GPO 6
GPIn 3 (Start)	A27	B27	GPO 5
Keyboard 5	A28	B28	GPO 4
Keyboard 6	A29	B29	GPO 10
Keyboard 7	A30	B30	GPO 9
Keyboard 8	A31	B31	0V Power Supply
GPIn 8 (limit switch P)	A32	B32	0V Power Supply
GPIn 9 (limit switch N)	A33	B33	24V Power Supply
GPIn 1	A34	B34	24V Power Supply

5.4.1 Analogue Input

Difference Input

Analogue input for nominal values or as process signal input, input resistor R_i = 20 kOhm, voltage range: -10V...+10V.

Resolution: 14 Bit

Analogue Input +: Plug X3 68-pole SCSI 2 Pin A1

Analogue Input -: Plug X3 68-pole SCSI 2 Pin A2

Note: Velocity command through the analogue input (see manual Setting Up and Parameter Setting of ND31, Chapter 3).

There are additional analogue inputs available:

Sensor Input A

Sensor input A: Analogue Input as process signal input, voltage range: -10V..+10V.

Resolution: 8 Bit

Sensor A Input +: Plug X3 68-pole SCSI 2 Pin A3

Sensor A Input -: Plug X3 68-pole SCSI 2 Pin B16

Sensor Input B

Sensor input B: Plug X3 68-pole SCSI 2 Pin A4

5.4.2 Analogue Output

The analogue output is not short-circuit proof!

Analogue Output 1

Plug X3 68-pole SCSI 2 Pin A5

±10 V analogue output for analogue process peripheral equipment control, loading 5 mA, resolution 8 bit.

When using output 1, GPO8 cannot be used as digital output.

Function: A 1 MHz PWM signal on GPO8 will be issued as a filtered analogue value.

Analogue Output 2

Plug X3 68-pole SCSI 2 Pin B3

±10 V analogue output for analogue process peripheral equipment control, loading 5 mA, resolution 8 bit.

When using output 2, GPO1 cannot be used as digital output.

Function: A 20 kHz PWM signal on GPO1 will be issued as a filtered analogue value.

Analogue outputs should not be used for regulator applications as the resolution of the 8 bit mode is generally not enough.

Note: Operation of the analogue output (see manual Setting Up and Parameter Setting of ND31, Chapter 4, Analogue Output, and Section 12.8.2 in this manual).

5.4.3 Digital Input: Group 1

Signal level of the digital input: GPIN1...10, Keyboard 5 - 8

"0": < 5 V

"1": > 13 V (max. 24 V +10 %)

Input resistance: 10,5 kOhm

Input:	Function:	Active Level	Plug X3 Pin
GPIn 1		"1"	A34
GPIn 2		"1"	A24
GPIn 3	Start	"1"	A27
GPIn 4	Reference Cam	"1"	A25
GPIn 5	Release	"1"	A26
GPIn 6		"1"	A21
GPIn 7		"1"	A23
GPIn 8	Limit Switch P	"1"	A32
GPIn 9	Limit Switch N	"1"	A33
GPIn 10		"1"	A22
Keyboard 5	Keyboard Connection	"0"	A28
Keyboard 6	Keyboard Connection	"0"	A29
Keyboard 7	Keyboard Connection	"0"	A30
Keyboard 8	Keyboard Connection	"0"	A31

5.4.4 Pulse Inputs

Difference inputs, RS422 standard

Input resistance: 15 kOhm

Impulse inputs can be used for:
1. Encoder connection ROD426

2. Frequency/direction standard
3. PLC signals

High level: The not inverted input is 0.2 V higher than the inverted input.

Low level: The inverted input is 0.2 V higher than the not inverted input.

Pin	Function 1	Function 2	Function 3
A15	Encoder Input /N	Diff. Input 1 -	Diff. Input 1 -
A16	Encoder Input N	Diff. Input 1 +	Diff. Input 1 +
A18	Encoder Input A	Direction Input +	Diff. Input 2 +
A20	Encoder Input /A	Direction Input -	Diff. Input 2 -
A17	Encoder Input B	Frequ. Input +	Diff. Input 3 +
A19	Encoder Input /B	Frequ. Input -	Diff. Input 3 -

Note: For Frequency/Direction Instruction see manual Setting Up and Parameter Setting of ND31, Chapter 2.

5.4.5 Digital Outputs

(not for encoder emulation)

Standard level: 24 V

Load: 100 mA

Pin	Output	Type	
B22	GPO 1	Open Collector	switching to 0V
B21	GPO 2	Open Collector	switching to 0V
B24	GPO 3	Open Emitter	switching to 24V
B28	GPO 4	Open Emitter	switching to 24V
B27	GPO 5	Open Emitter	switching to 24V
B26	GPO 6	Open Emitter	switching to 24V
B25	GPO 7	Open Emitter	switching to 24V
B23	GPO 8	Open Emitter	switching to 24V
B30	GPO 9	Open Emitter	switching to 24V
B29	GPO 10	Open Emitter	switching to 24V
B19	Key 1	Open Collector	switching to 0V

B17	Key 2	Open Collector	switching to 0V
B18	Key 3	Open Collector	switching to 0V
B2	Key 4	Open Collector	switching to 0V

Note: Programming of the Digital Outputs, see Section 12.3, Configuration.

Note: The sum of the load currents of the Open Collector/Emitter Outputs must not exceed 500 mA.

Example: The appropriate pull up resistor for GPO1 and GPO2 to couple a 24V 10mA PLC input with a level of 20V:

$$R = \frac{24\ V - 20\ V}{10\ mA} = 400\ \Omega$$

Power of the pull-up resistor: $P = \frac{24\ V^2}{400\ \Omega} = 1.44\ W$

Load current of the 24 V supply: $I = \frac{24\ V}{400\ \Omega} = 60\ mA$

5.4.6 Encoder Emulation

Difference outputs RS422 standard.

Pin	Function 1	Function 2
A9	N Encoder emulation	Difference output 1 +
A8	/N Encoder emulation	Difference output 1 -
A13	A Encoder emulation	Difference output 2 +
A12	/A Encoder emulation	Difference output 2 -
A11	B Encoder emulation	Difference output 3 +
A10	/B Encoder emulation	Difference output 3 -

Note: Ready for Operation of the Encoder emulation see manual Setting Up and Parameter setting of ND31, Chapter 5, Encoder emulation.

5.4.7 Ready for Operation Contact

Ready for operation potential free closing contact.
Loading: < 500 mA, < 100 V.
Ready for operation contact 1: Plug X3 68-pole SCSI2 Pin A6
Ready for operation contact 2: Plug X3 68-pole SCSI2 Pin A7

Function: BTB closes if there are no errors and if the inner circuit voltage is in use.

5.5 Bus Coupling

The ND31 is equipped with a RS232 or RS422/485 interface. RS232, RS422 and RS485 are standardized electronical data interfaces.

NOVOBUS has a loop structure. The controller sends data to drive No. n, that one to drive No. n-1 etc. Drive No. 0 sends back to the controller.

Data from the drive to the controller are also transmitted from drive to drive until they reach the controller.

To send the data back from drive No. 0 to the controller, a final connector on X4 on drive No. 0 is required which contains the respective bridges for RS232 or RS422/RS485. The lead and return wire are in the same cable.

NOVOBUS must be earthed! Normally it is earthed automatically by the controller. If not, e.g. if light wave conductor components have been fixed between the controller and ND31, alternatively a final connector has to be earthed (Pin 5 on RS232, Pin 3 on RS422/RS485).

The signals of the buses are separate from the active parts of ND31 by double isolation.

For the NOVOBUS shielded cables are required.

5.5.1 Serial Interface - Output Plug X4

Cable Standard RS232 or RS485 cable shielded.

Plug 9-pole D-Sub, pin contacts on ND31, sleeve contacts on the cable.

Pinning

Signal	Pins		Signal
RS422 Aout	1		
		6	RS422 Bout
Return wire 1	2		
		7	Return wire 2
RS232 TX	3		
		8	CAN L
RS232 DTR	4		
		9	CAN H
GND	5		

5.5.2 Serial Interface - Input Plug X5

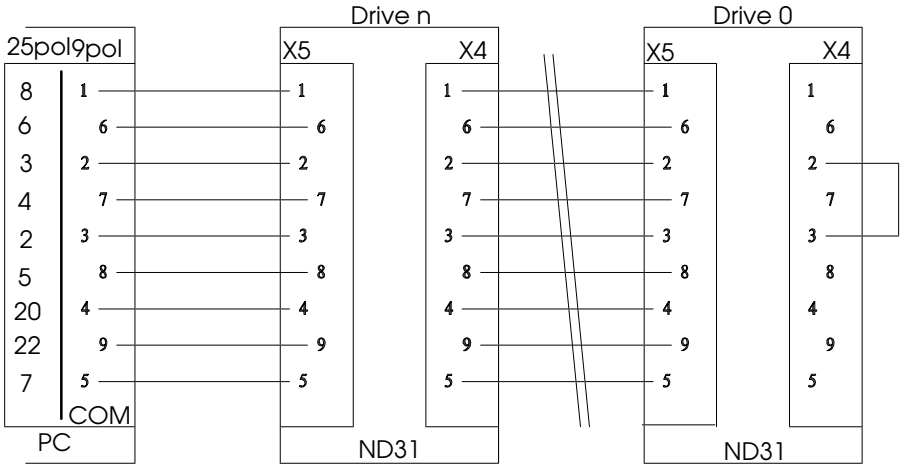
Cable Standard RS232 or RS422/485 cable, shielded.

Plug 9-pole D-Sub socket contact at ND31, pin contacts at the cable.

Pinning

Signal	Pins		Signal
RS422 Ain	1		
		6	RS422 Bin
Return wire 1	2		
		7	Return wire 2
RS232 RX	3		
		8	CAN L
RS232 DTR	4		
		9	CAN H
GND	5		

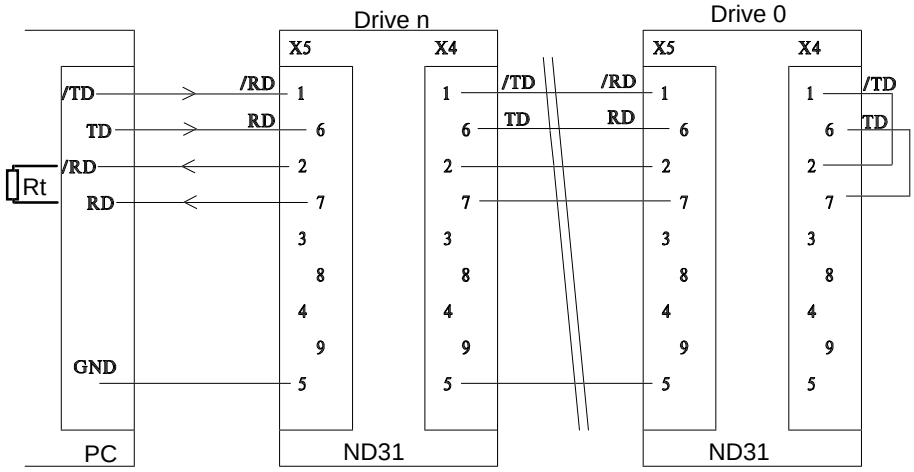
NOVOBUS with RS232



Notes: Pin 8 and 9 connect the drives at the same time with the CAN bus.

Only drive n has to be adjusted to RS232. The communication with the rest of the drives can be managed by RS422/RS485. ND31 can be used as an interface converter.

NOVOBUS with RS422, RS485



The receiving line in the controller must be terminated with a resistor: R_t = 100...120 Ω (ND31 has an integrated resistor).

5.6 Fan Connection

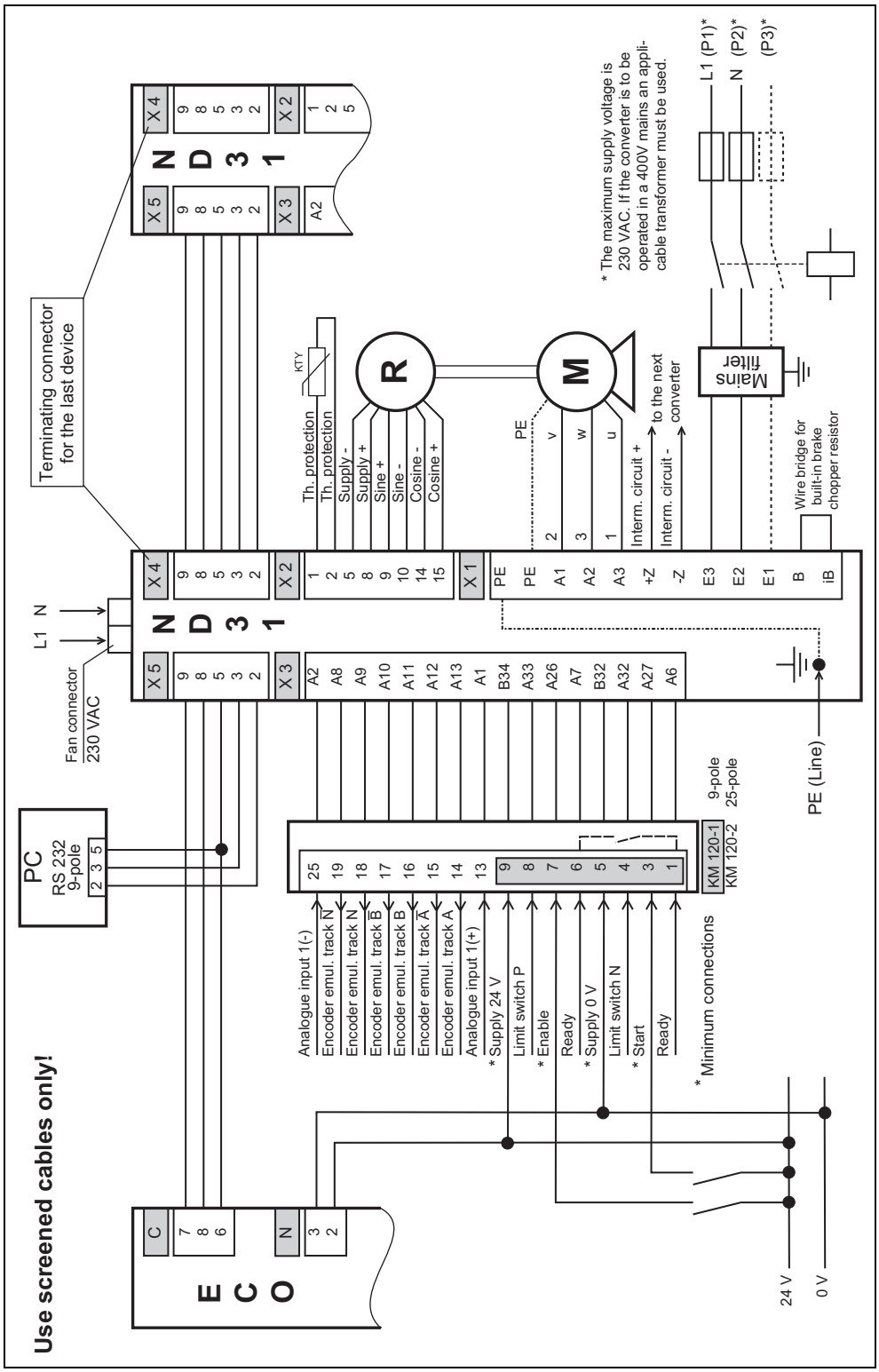
A 2-pole Combicon Plug can be found at the compact device to supply the installed fan:

Power supply: 220 VAC

Power input: < 200 mA

Fuse: 315 mA inert

5.7 Connection Example



Minimum connection of a ND31 to an EcoController GEL 8110

6. Installation

6.1 Mechanical Installation

ATTENTION!

Danger of destruction of the EcoServ!

Operating the EcoServ in a non-suitable environment can be destructible.

In case of unavoidable condensation moisture, remove the condensation moisture before starting with a suitable heater.

Ventilation

ND31 is only to be installed in an upright position. When installing the compact device the power connection plugs must be at the bottom.

When installing the 19” rack the air ventilator drawer must be installed below the ND31. The area round the ND31 ventilation outlets must not be blocked. The ND31 is not to be installed above heat omitting devices.

Environment

The installation can only be performed at a location free of dust, rust, metal chips, corroding or metal vapours, gases or liquids! Condensation moisture is to be avoided. If it is not possible to avoid the condensation if ND31 does not run please ensure that the moisture is completely removed before setting up.

ND31 devices may not be used in areas classified as dangerous, if they are not in approved housings and have not been tested.

6.2 Fuselage

The maximum voltage of the main supply is 230VAC. A higher voltage could lead to the destruction of the converter.

If the converter should be operated in the 400VAC mains, an appropriate transformer has to be used.

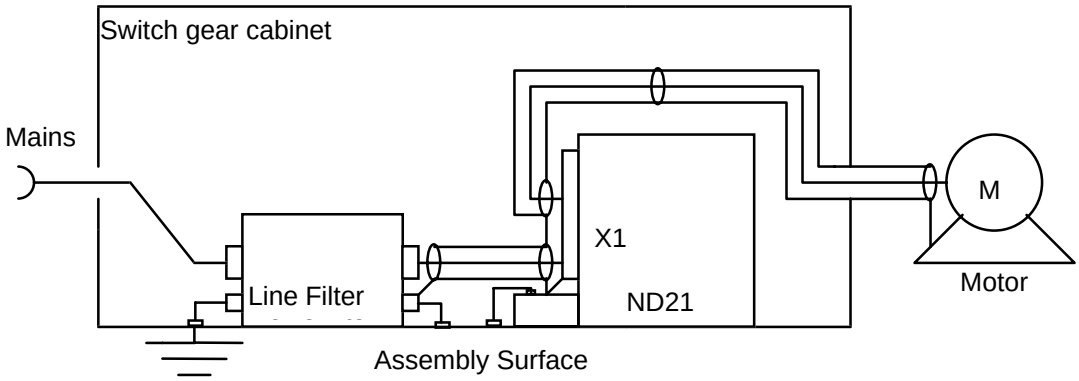
Device ND31	**3202**	**3204**	**3207**	**3212**
3 phases	3 x 4 A inert	3 x 8 A inert	3 x 14A inert	3 x 24 A inert

If several drives are to be fused together, the sum of each device has to be counted for the whole fuse.

Caution „High Voltage"! Fatal danger!

Contacts are only fused if earthing, mains and motor connection is executed as described in this chapter.

6.3 Earthing and Shielding



Note: To demonstrate more clearly, switch and fuse elements have not been mentioned in the above diagram. The elements have to be inserted that they do not disturb the principle course of the shields and earthing.

To follow the **EMC standard EN55011**, special attention should be paid on shielding and earthing.

Motor Wires The shield is to be fixed with cable clamps on one side of the motor housing and on the other side on the compact device or 19"rack of the ND31.

Brake When using motors with brakes, the cable has to be shielded till the brake relay.

Mains Filter The shield is to be fixed on the side of the filter with an appropriate earth connection of the line filter and the side of the ND31 with cable clamps on the compact device or 19"rack of the ND31.

The line filter must be screwed on the plane assembly board for the effective use of the line filter. Additionally the filter should be earthed with a short connection (2.5 mm^2) to the assembly board.

Appropriate Mains Filter

1phase	**3202**	**3204**	**3207**	**3212**
Schaffner	FN660-3-06	FN660-6-06	FN350-8-29	FN350-12-29

Corcom	3EP1 6FC10	3EP1/6EP1 6FC10	6EP1/10EP1 6FC10	16EP1 12FC10
Siemens	B84115-E-B30	B84115-E-B60	B84142-B8-R	

3phases	3202	3204	3207	3212
Schaffner	FN354-4/05	FN354-4/05	FN351-8-29	FN351-16-29
Corcom	6FCD10	6FCD10	6FCD10 F3719	12FCD10 F3737
Siemens			B84143-A8-R	B84143-A12-R

Protective Earth Wire

The PE connection of ND31 (Pin 14 X1) is to be connected with the earthing screw of the compact device or 19“rack. Connection cross section 2,5 mm² for 3202, 3204 and 3207 or 4 mm² for 3212.

Earthing of the compact device or the 19“ rack!

Earthing ND31

The compact device is to be screwed on the plain assembly board if possible. Additionally a short earthing connection ($10mm^2$) should be used between the earth bolt of the compact device or 19“rack towards the assembly board or earthing bus bar. The assembly board has to be earthed properly.

Requirements:

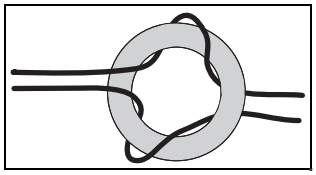
- Using the shields on both sides.
- Earthing connection short and thick.
- Fixing shields widely.
- Unshielded parts as short as possible.
- Earthing of the switchgear cabinet.
- Wires as short as possible.
- Signal and control wires always separated from the power supply wire.
- Freely supported wires can cause trouble (the active aerials the same as the passive aerials).

EMV-compatibility according to EN 55011 is only guaranteed if:

- A convenient line filter is used.
- A connection cable between ND31 and line filter as well as

power supply wire between ND31 and the motor is shielded.

- Shielding is connected with the earthing screw of the line filter, the compact device or 19“rack and the motor housing.
- The individual cores of the motor and mains cables are fed through ferrite toruses using the same winding sense, except for the PE wire.



6.4 Emergency Power Off Concept ND31

To prevent hazard to individuals or damage to the machine the emergency power off assembly has to be activated. Dangerous parts of the machine or the whole machine can be switched off as soon as possible.

Danger of injury by running motor!

Moving parts can be hazardous to individuals or cause damage to the plant.

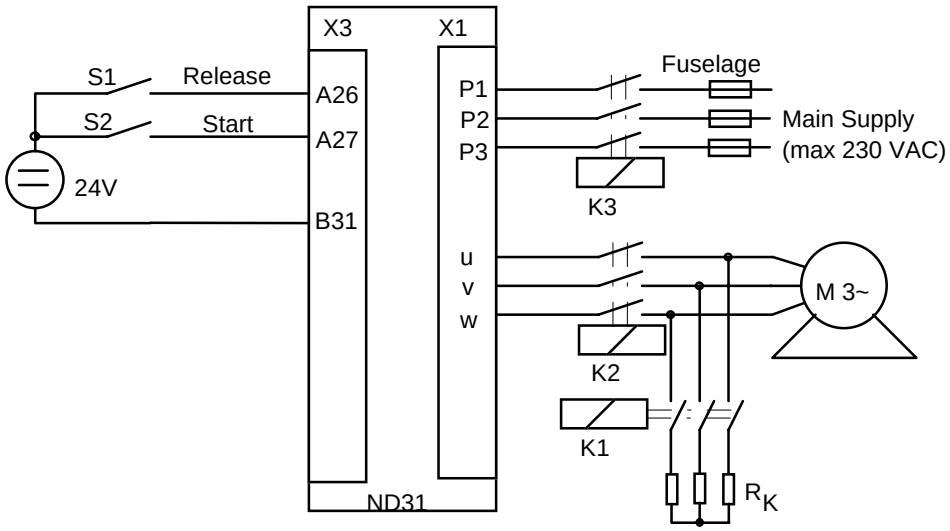
Therefore, the plant in which the EcoServ is installed must be equipped with an emergency power off (EPO) assembly. The EPO must stop the plant as quickly as possible.

6.4.1 General

This paragraph is about two different concepts according to the emergency power off:

- Short cut braking
- Regulated braking

When and which emergency power off concept is to be applied depends on the plant. Depending on the application, the correct emergency power off concept has to be chosen out.



For the emergency power off please abide the following instructions:

- The emergency power-off contactor between EcoServ and motor must be able to separate direct current which is similar to the peak value of the peak current of your EcoServ.
- By short circuit braking the brake resistor must have the correct dimension.

6.4.2 Short Circuit Braking

For the short circuit braking of the servo motor the power stage of the ND31 has to be blocked by stopping the current of input 26 on X3. At the same time contactor K1 is energized.

Calculation of the brake resistor R_k:

$$R_k = \frac{\text{max. speed (rpm)} \times \text{power radiant (V / rpm)}}{\sqrt{3} \times \text{peak current of the motor}}$$

6.4.3 Emergency Power Off with Controlled Braking

Danger by lag running drive after emergency off.

The drive slows down by emergency off, therefore please note:

- **<u>Do not</u> block the power stage! Regulated braking is only possible if the power stage is released (neither software nor hardware block).**
- **The control has to be adjusted correctly.**
- **By emergency off the motor stops after eliminating a possible tracking error!**
- **Please note, that a tracking error can occur by mechanical interference.**

ATTENTION!	**ND31 can only be stopped when the power stage is released (neither software nor hardware block).**

ATTENTION!	**ND31 stops the motor regulated. That requires a correct installation of the control. If the control is installed that a tracking error occurs, the tracking error will be eliminated. Only then the motor stops.**

Braking is activated by the pre-programmed ramp. Then the power stage can be blocked. Therefore the release input (Pin 26 of X3) is to prepare currentless.

Note: Braking can also be carried out by the analogue speed nominal value input if the nominal value is set to 0.

Additionally it is required to isolate the motor from the main supply. Therefore are two possibilities: Either by separating the main supply and ND31 with contactor K3 or the motor and ND31 with contactor K2. Only one of both contactors is required. Before separating ND31 from the motor, please note that ND31 has to be blocked.

If necessary, the switch off of contactor K2 has to be prolonged by taking adequate measures until braking has been finished and the regulator stops.

The requirements for a reliable isolation between ND31 and the motor is a complete operation area for the ND31, which guarantees that in case of an emergency power off the contact with current-carrying parts at the ND31 is excluded.

ATTENTION!	**Contactor K2 must be able to switch a direct current which is adequate to the peak value of the peak current of ND31.**

7. Designing a Drive Unit

In this chapter you will learn how to find the proper drive unit for a specific usage. In the given calculation example you will see how to select the proper drive for your needs.

7.1 Electrical Design

Question: Can a motor with a defined torque selected for ND31 achieve a certain speed with this torque?

Example: An application requires a torque of 12 Nm for acceleration and that a speed of 2600 rpm should be reached with this torque. It is to be tested whether this acceleration can be achieved with ND31 3207 and a motor with the following specifications.

The motor shows an instantaneous standstill torque of 6.8 Nm and may be overloaded 5-fold for quick acceleration. The torque constant is 0.34 Nm/A. The motor has 6 poles and its phase-to-phase winding resistance amounts to 1.7 Ω. Certainly, herewith the requested acceleration is possible. To determine if the required maximum speed can be reached with the specified torque, the following calculating scheme may be used:

Inductive voltage drop on motor:

$$U_L = n \times p \times L \times i \times 0.0453$$

with

n = speed [revolutions per minute] = 2600 rpm

p = motor polarity = 6

i = effective acceleration current [A] = 11.8 A

$$i = \frac{M}{(3 \times \text{torque constant})} = \frac{12\ \text{Nm}}{3 \times 0.34 \frac{\text{Nm}}{\text{A}}}$$

L = motor inductivity, phase to phase [H] = 0.0126 H

Inserted: U_L = 105.1 V

Resistive voltage drop on motor:

$$U_R = R \times i \times 0.866$$

with:

R = effective resistance, phase to phase [Ω] = 1.7 Ω

herewith: U_R = 17.37 V

CEMF of the motor:

$$U_E = \frac{1}{\sqrt{2}} \times Vg \times n / 1000$$

with

Vg = Voltage gradient, phase to phase [V/1000] = 88

herewith: U_E = 161.8 V

Voltage requirement for the motor:

$$U = \sqrt{(U_E + U_R)^2 + U_L{}^2} = 207.7V$$

Required intermediate circuit voltage:

$$U_{ZK} = \sqrt{2} \times U = 293.7\ V$$

With 3-phase 230V power connections the ND31 has an intermediate circuit voltage of 325 V. There is sufficient voltage present to reach the defined speed with the defined torque.

8. Novobus

In this chapter you will learn, how to use the NOVOBUS to control your drive unit.

8.1 General

NOVOBUS is an inexpensive solution for networking digital drives and also provides quick communication between controllers i.e. PC or PLC and drive units.

- Exchanging nominal and actual values (i.e. spin speed nominal and actual value).
- Transmitting new nominal position values for positioning axis.
- Parameter loop for motor regulators (i.e. setting and making on-line changes to regulator structures, regulator parameters and enabling maximum values etc.
- Transmitting control commands (start, stop, regulator stops...).
- Requesting important information (i.e. cooler and motor temperature, limiter switches, ready signals, in-position signals, additional external signals as process information, integrated operating hour counters, status of drive units, error messages).
- Controlling programmable analogue and digital outputs of drive units (i.e. for confirming shields or brakes, transmitting warning signals etc.).

RS232/RS485 The standard transmission hardware for the NOVOBUS are the standard serial interfaces RS232 or RS485 (Standard for all PCs and modern controllers).

No additional hardware extensions i.e. bus controllers, communication cards, protocol chips, intelligent bus plugs are required.

Driver All digital Novotron drive units are standard equipped with the necessary serial interface as well as software drivers for the NOVOBUS protocol.

A NOVOBUS driver as software library for PC applications is provided free of charge (NB31.LIB).

Loop Structure The only requirement for communication with the NOVOBUS is a loop connection of the PC with the drive units via RS232 or RS485 cables or via light wave conductors and the respective electro-optical transformers.

Up to 250 axes can be controlled in one loop. The drives are automatically addressed according to their position in the loop. For higher transmission speeds or connecting cycled machine components drives can be distributed to several loops.

8.2 Features

Velocity

The duration for a byte transfer is 286.46 ms at a speed of 38,400 bits/sec.

The required time for completing nominal and actual value exchange with speed regulated drives is:

Drives per ring	Time
1	0.86 ms
2	2.0 ms
3	2.9 ms
4	3.7 ms
5	4.6 ms
6	5.4 ms

The required time for transferring new nominal value positions for positioning axes is:

Drives per ring	Time
1	4.01 ms
10	40.39 ms
100	401.33 ms
250	1002.79 ms

8.3 Requirements for Transmission

RS232 or RS485 alternatively.

Light wave conductor may be used in connection with interface converters.

Transmission speed: 38,400 bits/sec

Transmission is performed with 8 data bits, 1 parity bit (odd parity) and 1 stop bit.

8.4 Bus Structure

NOVOBUS has a loop structure: The drives can be connected to one or more loops.

Master/Slave

Per loop: 1 Bus Master (controller),
max. 250 Slaves (drives)

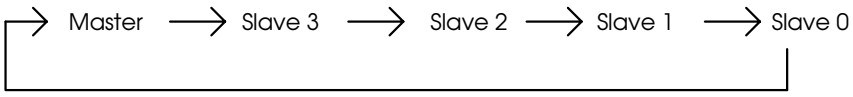
In normal operation, the Slaves can only answer the Master telegram. In case of a time-out error Slaves may also transmit error telegrams independently.

8.5 Device Addresses

250 Axes per Ring

Up to 250 axes can be controlled by one loop. Drives are automatically addressed according to their position in the loop. Numbering loops of the devices begin with the last one in the loop which has the address “0”. The address of the first device in the loop is N-1, whereas N pertains to the number of Slaves.

i.e.: with 4 axes



9. Bus-Definition

The Master (controller) transmits telegrams continuously. Most transmissions contain an address (exception: SYNCO and PAUSE).

Devices for which a transmission is not to be intended continue to send telegrams. The intended address answers to the telegram. The length of the answer is always identical with the length of the Master transmission.

9.1 Transmission Syntax

Synchronized byte (obligatory)

Address byte (optional)

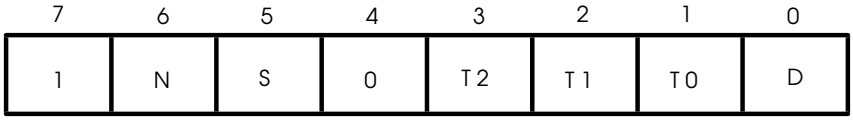
Process data (2 bytes, optional)

Parameter data (1-7 bytes, optional)

All bytes are sent with odd parity. The net transmission length (process data + parameter data) may consist a maximum of 7 bytes. In a transmission with process data the parameter data may be a maximum of 5 bytes long.

9.2 Synchronization Byte

The synchronization byte is always the first byte of a transmission. It contains the code for the length of the transmission.



N = 1:	Next with short address (or = 0)
S = 1:	Short address
T2-T0:	Net transmission length (without synchro byte and address byte, 0...7)
D = 1:	The transmission contains process data information (2 bytes data channel)

Short Address When S = 1 and N = 0, the same drive which received the last transmission will be addressed.

When S = 1 and N = 0 the next drive will be addressed (Address = Address 0+1).

When S = 0 and N = 0 an address byte will follow.

If no process data bus or parameter bus is active the synchro byte “SYNCO” will be sent to maintain a continuous data flow. “SYNCO” will be forwarded without change by the receiver.

“SYNCO”: H’80

To loosen the data flow the synchro byte “PAUSE” can be sent. It will be ignored by the receiver (no response).

“PAUSE”: H’81

9.3 Address Byte

7	6	5	4	3	2	1	0
A 7	A 6	A 5	A 4	A 3	A 2	A 1	A 0

The Master transmission A7-A0 contains:

k-N

k = Device address in the loop

N = Number of passive devices (Slaves)

All devices increase the address by 1 and forward the transmission with the new address. A drive is addressed if the address is “0” after incrementing. The non-addressed drives pass the entire transmission without checking the contents.

Example: N=5, the controller wants to communicate with the device axis 2: (k-N = 2 - 5 = -3 = H’ fd).

7	6	5	4	3	2	1	0
A 7	A 6	A 5	A 4	A 3	A 2	A 1	A 0

Master:	1	1	1	1	1	1	0	1	(H’ fd = k-N)
Axis4:	1	1	1	1	1	1	1	0	(H ’fe)
Axis3:	1	1	1	1	1	1	1	1	(H' ff)
Axis2:	0	0	0	0	0	0	0	0	(H’00) ← !!!
Axis1:	0	0	0	0	0	0	0	1	(H’01)
Axis0:	0	0	0	0	0	0	1	0	(H’02 = k)

The incremented address is zero at the addressed axis (Axis2). The Master receives the answer for its transmission with the address “k” (in the above example, in which Axis2 was addressed: H’02).

9.4 Process Data Bus

With this bus a faster nominal and actual value exchange can be realized. Hereby the lowest bit in the synchronization byte is set (see Section 9.2, Synchronization Byte**).** The data are always 2 bytes long. In the transmission, first the byte with the highest value (MSB) and then the one with the lowest value (LSB) is sent.

9.5 Parameter Bus

With the assistance of the parameter bus the drives can receive parameters. Commands can be sent, and information from the drives can be received. A command in the parameter bus consists of a command byte, data bytes (0...4) and a check byte.

With a NOVOBUS transmission several commands can be sent through the parameter bus and respectively a command in the parameter bus can be divided into several transmissions. The answer to a command is the same length as the command itself (2 to 6 byte). The command byte and the checking byte must not have the value H’00.

9.6 Control Byte in the Parameter Bus

The Master (controller) sends all commands into the parameter bus with a test sum as checking byte (+ check sum). This check sum will be tested by the signalled drive.

The command will be carried out when the check sum is correct, otherwise the drive signals an error (see Section 9.7, Error Handling).

The check sum is the sum of bytes in one command. If the sum “0” is transmitted, the check sum will be corrected. Instead of 0, 1 is to be sent (H’00 is reserved for error messages). The responded drive forms a new check sum out of the answer and sends its two's complement (– check sum).

The check sum pertains to the parameter bus and is only made up of the bytes in the parameter bus. Synchro byte, address byte and process data will not be considered in the check sum.

9.7 Error Handling

When the drive notices an error in the communication (parity error, framing error, improper synchro byte, incorrect command in parameter bus, improper command parameter or incorrect check sum), it goes into an error mode.

The drive which first detects the error answers with H'00 to all received bytes. The following axes can then detect the error very rapidly when they are addressed with: incorrect synchro, command or checking bytes (may not be H'00), or improper command parameter (in case a H'00 is not accepted here).

A non-addressed drive checks the contents of the transmission. It can only detect the error when the next synchro byte fails. A transmission can have a maximum of 9 bytes. If the error is in the address byte, the other axes which have only received H'00 bytes since the error occurred may not notice the error until the 9th byte.

An error free transmission can only be contained in the address byte (byte 1), in the process data bus (byte 2) and in the data area of the parameter bus (max. 4 bytes). That means a maximum of 7 times consecutively of H'00 can be possible. The drives have an error condition that count the number of zero bytes which have been sent from the preceding drive. If the drive receives 8 times H'00 without interruption the preceding drive is in the error condition.

In this case the sent bytes are controlled for a checking sequence. If a checking sequence is detected it returns to normal operation mode (see Section 9.8, Checking Sequence).

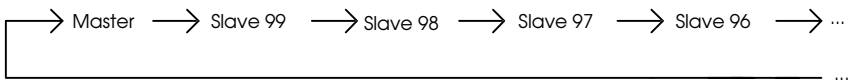
To be sure that also the following drive recognizes the error, at least 9 times H'00 has to be sent. For a drive to detect that the preceding drive is in an error condition it must receive additional 8 zero bytes.

Therefore all drives in error condition first send H'00 17 times. If they detect that the preceding drive in the loop is in an error condition they incrementally forward all received bytes.

The Master receives first of all a maximum of 25 H'00 bytes during an error, afterwards it receives the address of the drive which has recognized the error. That enables an easy location of the error.

Example: 100 axes

The Master reads one byte each out of the RAM of drives no. 95 to 99. An error bit will be transmitted between the drives no. 98 and 97, drive no. 97 detects that as a parity error.



The 1st Telegram

1. Byte:	H'88 =	Synchro byte (follows address byte and 4 bytes in the parameter bus, no process data).
2. Byte:	H'FB =	-5 = 95-100 (Slave 95 is addressed in a loop with 100 Slaves in the ring).
3. Byte:	H'C0 =	Read byte command for ND31
4. Byte:	H'13 =	AddressL, LSB of address H'FE13
5. Byte:	H'FE =	AddressM, MSB of address H'FE13
6. Byte:	H'D1 =	Checking byte (C0+13+FE = 1D1)

The following transmissions differ only in the 2nd byte (96-100=-4 = H'FC, 97-100= -3 = H'FD, ...)

M	S	S	F	S	S	S	...	S
a	l	l	e	l	l	l		l
s	a	a	h	a	a	a		a
t	v	v	l	v	v	v		v
e	e	e	e	e	e	e		e
r	9	9	r	9	9	9		0
	9	8		7	6	5		0
88	88	88		88	88	88	...	88
FB	FC	FD		FE	FF	00		5F
C0	C0	C0		C0	C0	C0		C0
13	13	13		13	13	13		13
FE	FE	FE		FE	FE	>88		88
D1	D1	D1		D1	D1	+A5		A5
88	88	88		88	88	88		88
FC	FD	FE		FF	00	01		60
C0	C0	C0		C0	C0	C0		C0
13	13	13	12	!00	00	00		00
FE	FE	FE		00	!00	00		00
D1	D1	D1		00	00	00		00
88	88	88		00	00	!00		!00
FD	FE	FF		00	00	00		00
C0	C0	C0		00	00	00		00
13	13	13		00	00	00		00
FE	FE	FE		00	00	00		00
D1	D1	D1		00	*00	00		00

88	88	88	00	00	00		00
FE	FF	00	00	00	*00		*00
C0	C0	C0	00	00	00		00
13	13	13	00	00	00		00
FE	FE	88	00	00	00		00
D1	D1	A5	00	00	00		00
88	88	88	00	00	00		00
FF	00	01	#00	00	00		00
C0	C0	C0	00	#00	00		00
13	13	13	00	01	00		00
FE	88	88	00	01	#00		#00
D1	A5	A5	00	01	02	...	61
88	88	88	00	01	02		61
9C	9D	9e	00	01	02		61
.	.	.	.	.	.	.	.	.

Remarks:

>: Answer byte in a transmission (contents of the memory cell).

+: New check sum.

!: The drive detects an error.

***:** The drive detects that the preceding drive is in error mode.

#: The 17th sent zero byte after the error detection.

The message H'00 indicates an error to the Master, bytes H'61 = 97 means that the error has been noticed by Slave 97.

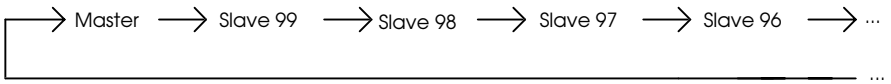
9.8 Checking Sequence

If the Master detects an error in data traffic, a checking sequence is sent to reset the drives. The first 17 bytes of the checking sequence are H'00, so that all drives which still did not detect the error turn into error mode. After the checking sequence the Master can repeat the uncompleted commands.

The checking sequence is:

(17 times H'00) H' ff H'44 H'72 H'4c H'41

Example: 100 axis and axis no. 97 - 0 are in error mode. Axis no. 99-98 could not detect any error in the communication. The Master has just sent a transmission when the error has been detected by an unexpected 0-byte. After detecting the error the Master sends 17 times H'00. Then the bus sets back with a check sequence.



	Master	Slave 99	Slave 98	Slave 97	Slave 96	Slave 95	...	Slave 00
Started Telegram	88	88	88	00	01	02	...	61
17 Zero Bytes	00	01	02	00	01	02	...	61
	00	00	00	00	01	02		61
	00	00	00	00	01	02		61
	00	00	00	00	01	02		61
	00	!00	!00	00	01	02		61
	00	00	00	00	01	02		61
	00	00	00	00	01	02		61
	00	00	00	00	01	02		61
	00	00	00	*01	02	03		62
	00	00	00	01	02	03		62
	00	00	00	01	02	03		62
	00	*00	*00	01	02	03		62
	00	00	00	01	02	03		62
	00	00	00	01	02	03		62
	00	00	00	01	02	03		62
	00	00	00	01	02	03		62
	00	00	00	01	02	03		62
Check Code	FF	@FF	@FF	@FF	@FF	@FF	...	@FF
	44	44	44	44	44	44		44
	72	72	72	72	72	72		72
	4C	4C	4C	4C	4C	4C		4C
	41	41	41	41	41	41		41
Repeating Transmission	88	88	88	88	88	88	...	88
	FC	FD	FE	FF	00	01		60
	C0	C0	C0	C0	C0	C0		C0
	13	13	13	13	13	13		13
	FE	FE	FE	FE	>88	88		88
	D1	D1	D1	D1	+A5	A5		A5

Remarks:

!: The drive detects an error

***:** The drive detects that the preceding drive is in error mode

@: The drive detects the first byte of the checking sequence

>: Answer byte in a transmission (contents of the memory cell)

+: New check sum

After the check sequence the bus is again ready for operation.

9.9 Time-out Error

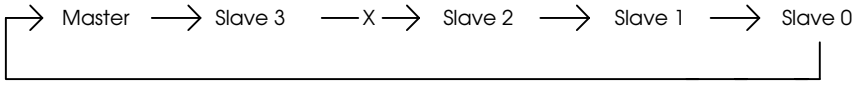
ATTENTION! **This function is not available in the present version.**

If a byte is not received within at least 10 ms, a time-out error has occurred. This function can be switched off.

When a time-out error occurs, the drive turns into error condition and waits further 10 ms to allow other drives to detect the time-out-error and react accordingly.

After this waiting period the drive begins to send zero bytes. The other drives detect the error at least after the 8th H'00 and then increment the received bytes. The Master receives the address of the error source.

Example: Disconnection between axis 3 and axis 2.



Slave2:	...	00	00	00	00	00	00	00	00	00
Slave1:	...	00	00	00	*****01	01	01	01	01	01
Slave0:	...	00	00	*****01	02	02	02	02	02	02

*****: The drive detects that the previous drive is in error mode.

The received H'02 bytes shows the Master that Axis2 has identified the error. Either the connection between Axis3 and Axis2 is interrupted or Axis3 is not ready for operation.

10. CAN Bus

10.1 Data exchange with Controllers GEL 8100

The Controllers GEL 8100 can control up to 6 ND31 converters via the CAN bus: the controller transmits the nominal speed to the converter, and the converter transmits its actual position to the controller.

10.2 CAN bus configuration

In the RAM of the ND31 several memory locations for adapting the CAN bus to the controller exist:

Address	Byte	Designation	Function, value
0xfee8	1	CANinitBTR0	Timing configuration; input: 40
0xfee9	1	CANinitBTR1	Timing configuration; input: B9
0xff11	1	CANCFG	CAN configuration; input: FF
0xff16	1	CANTimeout	Timeout time 10 ms/bit; input: 5 (50 ms)
0xff39	1	CANmaster	Identifier for Master telegrams; input for Axis1: 30 Axis2: 31 Axis3: 32 Axis4: 33 Axis5: 34 Axis6: 35
0xff3a	1	CANslave	Identifier for Slave telegrams; input for Axis1: 20 Axis2: 21 Axis3: 22 Axis4: 23 Axis5: 24 Axis6: 25
0xff3b	1	CANtime	Identifier for SYNC telegrams; input: 40

11. ND31 Specific Commands

11.1 Read Commands

Read Byte

ReadByte: Reads a byte from the memory of the ND31:

H'FD80-H'FF7F RAM

Command	H'C0	AddrL	AddrH	+CheckSum
Answer	H'C0	AddrL	Data	-Checksum

Read Word

ReadWord: Reads a word (2 byte) out of the ND31-memory:

H'FD80-H'FF7F RAM

Command	H'C1	AddrL	AddrH	H'3F	+CheckSum
Answer	H'C1	AddrL	DataL	DataH	-Checksum

Read WordX

ReadWordX: Reads a word (2 byte) out of the external memory of ND31. The possibly area depends on the memory extension:

H'4000-H'FFFF ExtRAM

Command	H'C9	AddrL	AddrH	H'3F	+CheckSum
Answer	H'C19	AddrL	DataL	DataH	-Checksum

Read Long

ReadLong: Reads 4 Byte from the memory of ND31:

H'0000-H'FFFF RAM

Command	H' C7	AddrL	AddrH	H' 31	H' 32	H' 3F	+Checksum
Answer	H' C7	AddrL	Data0	Data1	Data3	Data4	-Checksum

Checksum: '1' = H'31, '2' = H'32, '?' = H'3F

11.2 Write Commands

Write Byte

WriteByte: Writes a byte into the memory of the ND31:

H'FE00-H'FE7F RAM
H'FEA0-H'FF7F RAM

Command	H'82	Data	AddrL	AddrH	+ CheckSum
Answer	H'82	Data	AddrL	AddrH	- Checksum

Write Word

WriteWord: Writes a word (2 bytes) into the memory of ND31:

H' FE00-H' FE7F RAM
H' FEA0-H' FF7F RAM

Command	H'63	DataL	DataH	AddrL	AddrH	+CheckSum
Answer	H'63	DataL	DataH	AddrL	AddrH	-Checksum

Write WordX

WriteWordX: Writes a word (2 Byte) into the external memory of ND31. The possible range depends on the memory extension.

H' 4000-H' FFFF Ext RAM

Command	H' 6A	DataL	DataH	AddrL	AddrH	+CheckSum
Answer	H' 6A	DataL	DataH	AddrL	AddrH	-Checksum

Write Long

WriteLong: Writes a Longinteger number (4 bytes) into the memory of ND31.

H' FE00-H' FE7F RAM
H' FEA0-H' FF7F RAM

Command	H' C8	D0	D1	D2	D3	AddrL	AddrH	+CheckSum
Answer	H' C8	D0	D1	D2	D3	AddrL	AddrH	-Checksum

The data bytes are labelled with D0 (LSB) ...D3 (MSB).

11.3 Bit Manipulation and Logical Commands

AND

And: Sends a logical AND bit for bit into the memory of ND31 (RAM := RAM & Data).

AddrH has not to be given, as the logical commands only refer to the memory range from H'FF00.

H'FF00-H'FFFF RAM

Command	H'A4	Data	AddrL	+Checksum
Answer	H'A4	Data	AddrL	-Checksum

OR

Or: Sends a logical OR bit to bit into the memory of ND31. (RAM:=RAM or Data).

AddrH must not be given, as the logical commands only refer to the range of memory from H'FF00.

H'FF00-H'FF7F RAM

Command	H'A5	Data	AddrL	+Checksum
Answer	H'A5	Data	AddrL	-Checksum

11.4 Input/Output Commands

Not yet available.

11.5 Reset H8

Reset

Releases a reset of the ND31 operating program. Every data which has not been saved in the EEPROM will be lost.

Command	H'DD	H' 21'	+Checksum
Answer	H'DD	H' 21'	- Checksum

12. Set-up and Output Capabilities of the EcoServ

In this chapter you are informed about the set-up capabilities of the EcoServ. In addition, explanations of readable parameters are provided.

Parameter settings affecting the control circuit, can only be made when you have a complete understanding of the respective parameter and its properties.

There are two ways of changing the EcoServ settings:

- Via set-up software
- Via NOVOBUS

12.1 Requirements

With the set-up software, several parameters can comfortably be edited by the way of menu settings. If this possibilities are not sufficient for your application, please find the necessary information in this chapter.

All parameters can be changed or read by the NOVOBUS. The NOVOBUS driver software makes the required write and read-commands available.

With the set-up software you can perform all settings and read the individual parameter.

To set and read the parameters with the set-up software, an IBM compatible PC and a bus cable is required.

12.2 EcoServ Memory

Your EcoServ has 2 different memories:

- Battery buffered RAM-memory with 512 Byte, addresses: FD80h - FF7Fh.
- External memory (size according to the RAM-size), addresses: 0000h - FFFFh

RAM-Memory A change in RAM directly affects the circuit. When the ND31 power supply (24V) is switched off and on, changes will not be lost. The RAM is battery buffered.

The RAM-memory of the ND31 is readable in the service menu with the function RAM-Monitor. Changes are to be made with the

function Write-RAM (see manual Set-up and Parameter Setting of ND31, Section 2.1.11.2, Service Menu).

Some of the below mentioned addresses are not described in the service menu. But they can be read through the NOVOBUS commands.

12.2.1 RAM Memory

Address	*Bytes*	*Designation*	*Description*
0x01e0	2	@Tabelle	Table Interpolation
0x01e2	2	@PS21	Relative positioning
0x01e4	2	@Referenz	Reference drive
0x01e6	2	@PSA	Absolute positioning
0x01e8	2	@Feininterpol	Fine interpolation
0x01ea	2	@dummy	Dummy address
0x01ec	2	@msollAn	Inertia command
0x01ee	2	@SetIstwert	Actual value setting
0x01f2	2	@Nullsuche	Referencing
0xc016	2	TopZero	Internal parameter
0xf000	1	_iaist	Motor current actual value phase A
0xf001	1	_ibist	Motor current actual value phase B
0xfe00	2	errorcode	Error code
0xfe0a	2	GPO	Output word digital outputs
0xfe0c	2	GPIN	Input word digital inputs
0xfe10	2	Warning	Internal parameter
0xfe12	2	nsollF	Internal parameter
0xfe1a	2	FIsoll	Internal Parameter
0xfe1c	2	VzSchlInc	Slipping distance increments with prefixes
0xfe1e	2	VzSchlUmdr	Slipping distance revolution with prefixes
0xfe20	2	Phi1	Internal parameter
0xfe2a	2	ps-umdr	Revolution counter for relative positioning
0xfe2c	2	ps-imp	Impulse counter for relative positioning
0xfe3a	2	?Tabelle	Table first address (only table interpolation)
0xfe3c	2	CANinput1	CAN-Parameter
0xfe3e	2	CANinput2	CAN-Parameter
0xfe40	2	CANinput3	CAN-Parameter

Address	*Bytes*	*Designation*	*Description*
0xfe42	2	NBinput	Internal parameter
0xfe44	2	Phi4	Internal parameter
0xfe46	2	nsoll2	Inertia nominal value of the position regulator
0xfe48	2	STROD	Internal parameter
0xfe4c	2	InternSoll	Internal Inertia nominal (e.g. positioning control)
0xfe4e	2	psa_positionH	Target revolution (absolute positioning)
0xfe50	2	psa_positionL	Target increments (absolute positioning)
0xfe52	1	psa_status	Status of the positioning control
0xfe54	2	LageSoll	Position nominal value increments
0xfe56	2	UmdrSoll	Position nominal value revolution
0xfe58	2	aSoll	Acceleration nominal value
0xfe5a	2	AnIn1Old	Internal parameter
0xfe5c	2	AnInput1	Value of analogue input 1
0xfe5e	2	mSoll	Moment nominal value
0xfe60	2	Sollwert	Nominal value address
0xfe62	2	nSoll	Regulator nominal value (without position regulator)
0xfe64	2	nIntegrator	internal parameter
0xfe66	2	Sync	Internal parameter
0xfe68	2	nist	Velocity actual value
0xfe6a	2	Pa0	Internal parameter
0xfe6c	2	Pa1	Internal parameter
0xfe6e	1	RautojuCSR	Resolver auto adjustment control-register
0xfe6f	1	Pa2	Internal parameter
0xfe72	2	MaxSchleppInc	Memory for maximum slipping error in increments
0xfe74	2	Lage-nsoll	Internal parameter
0xfe7a	1	BalCnt	Counter for ballast switching
0xfe7b	1	CANCont	CAN-Parameter
0xfe7c	2	LageIst	Position actual value (increments)
0xfe7e	2	UmdrIst	Position actual value ((revolution)
0xfe84	3	Seriennummer	Serial number in BCD format
0xfe88	1	Imax	Rated current ND31

Address	*Bytes*	*Designation*	*Description*
0xfe8b	1	HwVersion	Hardware configuration
0xfe92	2	BetriebStd	Operating hours counter
0xfe94	2	SperreStd	Operating hours counter
0xfe96	1	BetriebMin	Operating hours counter
0xfe97	1	SperreMin	Operating hours counter
0xfea0	2	Steuerbits	
0xfea2	2	?SPS	Pointer to program in ext. RAM
0xfea8	2	?Rampe	Pointer to acceleration ramp
0xfeaa	2	?Rampe-	Pointer to braking ramp
0xfeac	2	?CANout	CAN-Parameter
0xfeae	2	?512us	Pointer 512us-command
0xfeb0	2	?FILage	Internal parameter
0xfeb2	2	?CANControl	CAN-Parameter
0xfeb4	1	BremseT1	
0xfeb5	1	BremseT2	
0xfeb6	2	?FForward	Internal parameter
0xfeb8	2	?nSoll	Pointer to structure of the drive
0xfeba	2	?mMax	Pointer to mMax
0xfebc	2	?mSoll	Pointer to mSoll
0xfebe	2	?Sollwert	Pointer for the structure of the drive
0xfec0	2	CANTime2	CAN-Parameter
0xfec2	2	?GPO	Pointer to GPO
0xfec4	2	?SchRampe	Pointer to quick stop ramp
0xfec6	1	Stopdauer	
0xfec7	1	GPOMaske	Mask for output word
0xfec8	2	?512usA	Pointer 512usA-command
0xfeca	2	?512usB	Pointer 512usB- command
0xfecc	2	?FIUmdr	
0xfece	2	?102us	Pointer 102us- command
0xfed0	2	NPIOffs	Internal parameter
0xfed2	2	CANIDLSB	CAN-Parameter
0xfed4	2	dLage	Internal parameter
0xfed6	2	RefV3	Reference drive internal velocity
0xfed8	2	Window	In-Position-Window
0xfeda	2	RefLage	Actual value setting Increments
0xfedc	2	RefUmdr	Actual value setting revolution

Address	*Bytes*	*Designation*	*Description*
0xfede	2	RefV1	Reference drive velocity 1
0xfee0	2	RefV2	Reference drive velocity 2
0xfee2	2	RODinM	Internal parameter
0xfee4	2	nMax	Maximum inertia
0xfee6	2	ps-v0	Positioning velocity
0xfee8	1	CANinitBTR0	CAN-Parameter
0xfee9	1	CANinitBTR1	CAN-Parameter
0xfeea	2	TCycle	Internal parameter
0xfeee	1	FIVerrundung	Internal parameter
0xfef0	2	PhiPO	Resolver adjustment
0xfef2	2	AnIn1Offset	Offset analogue input 1
0xfef4	2	Impulszahl	Impulse number of the encoder emulation
0xfef6	1	nSollFilter	Nominal value filter
0xfef7	1	Pole	Motor pole number
0xfef8	1	iKp	Current regulator: P component
0xfef9	1	iKi	Current regulator: I component
0xfefa	2	Rampe	Acceleration ramp
0xfefc	2	Rampe-	Braking ramp
0xfefe	2	SchRampe	Quick stop ramp
0xff00	1	InitIOM1	Internal parameter
0xff01	1	MaxTempMot	Maximum motor temperature
0xff02	1	ResolvKomp	Resolver compensation
0xff03	1	emk0	EMK of the motors
0xff04	1	NB_Init	Baud rate NOVOBUS
0xff05	1	Feedback	Feedback system
0xff06	1	FICSR	Internal parameter
0xff07	1	bank	Internal parameter
0xff08	1	CANSlaveBit8	CAN-Parameter
0xff09	1	CANSlaveB0	CAN-Parameter
0xff0a	1	CANSlaveB1	CAN-Parameter
0xff0b	1	CANSlaveB2	CAN-Parameter
0xff0c	1	CANSlaveB3	CAN-Parameter
0xff0d	1	CANSlaveB4	CAN-Parameter
0xff0e	1	CANSlaveB5	CAN-Parameter
0xff0f	1	CANSlaveB6	CAN-Parameter
0xff10	1	CANSlaveB7	CAN-Parameter
0xff11	1	CANCFG	CAN-Parameter

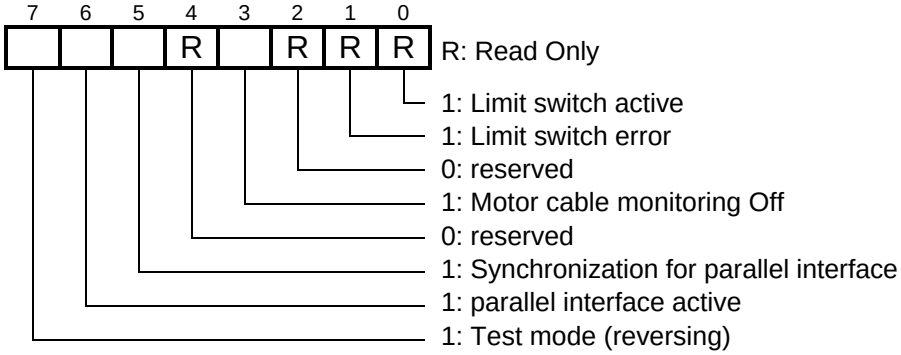
Address	*Bytes*	*Designation*	*Description*
0xff12	2	?AnOut2	Pointer to the address for analogue output 2
0xff14	1	AnOut2Fakt	Scale factor for analogue output 2
0xff15	1	AnOut2Offs	Offset for analogue output 2
0xff16	1	CANTimeout	CAN-Parameter
0xff17	1	FKSteuerung	Internal parameter
0xff18	2	KommSpurOff	Internal parameter
0xff1a	2	Polabstand	Internal parameter
0xff1c	2	Impulslaenge	Internal parameter
0xff1e	2	KommLaenge	Internal parameter
0xff20	1	AnOutConfig	Analogue-output configuration byte
0xff21	1	MotConfig	Motor-configuration byte
0xff22	1	AnIn2Fakt	Scale factor analogue input 2
0xff23	1	AnIn2Offset	Offset analogue input 2
0xff24	2	?AnOut1	Pointer to address for analogue output 1
0xff26	1	AnOutOffs	Offset analogue output 1
0xff27	1	AnOutFakt	Scale factor analogue output 1
0xff28	2	?LageIst	
0xff2a	1	Betriebsart	Operation mode
0xff2b	1	RefUmdrH	Internal parameter
0xff2c	2	Schleppfehler	Maximum allowed slipping error
0xff2e	1	i0max	Effective current limiter
0xff2f	1	LKd	Position regulator advanced control
0xff30	1	LKp	Position regulator P-part
0xff31	1	nKd	Speed regulator advanced control
0xff32	1	nKp	Speed regulator P-part
0xff33	1	nKi	Speed regulator I-part
0xff34	1	MaxBalCnt0	Threshold ballast switching control
0xff35	1	mMax	Peak current
0xff36	2	mMax16	Peak current
0xff38	1	CANservice	CAN-Parameter
0xff39	1	CANmaster	CAN-Parameter
0xff3a	1	CANslave	CAN-Parameter

Address	*Bytes*	*Designation*	*Description*
0xff3b	1	CANtime	CAN-Parameter
0xff3c	1	Freigabe0	Start position
0xff3d	1	SwVersion	Software configuration
0xff3e	1	AnIn1Fakt	Scale factor analogue input 1
0xff3f	1	nFilter	Tacho filter
0xff43	1	UmdrIstH	Internal parameter
0xff52	1	NBcontrol	Enable via NOVOBUS
0xff54	1	MotTemp	Motor temperature (resistance value)
0xff5b	1	UmdrH	
0xff66	2	AnIn_msoll	
0xff68	2	SchleppInc	Actual slipping error increments
0xff6a	2	SchleppUmdr	Actual slipping error revolution
0xff6e	2	Ilimit	Internal parameter
0xff70	2	DImsoll	Internal parameter
0xff73	1	ps-status	Status positioning control
0xff79	1	RefStatus	Status reference drive
0xff88	2	_Phi	Internal parameter
0xffb2	1	iMax	Internal parameter
0xffe0	1	ADDRA	Internal parameter
0xffe2	1	ADDRB	Internal parameter
0xffe4	1	ADDRC	Internal parameter
0xffe6	1	ADDRD	Internal parameter
0xfff2	1	Status	Status ND31
0xfff3	1	CANcontrol	Release through CAN-Bus
0xfff4	1	SPScontrol	
0xfff5	1	CANStat	CAN-Parameter
0xfff6	1	Second	Internal parameter
0xfff8	1	Temp0	End amplifier cooler temperature
0xfff9	1	Temp1	End amplifier cooler temperature
0xfffa	1	Temp2	End amplifier cooler temperature
0xfffb	1	Temp3	End amplifier cooler temperature

12.3 Configuration

12.3.1 The Byte SwVersion

RAM-Parameter Address: H' FF3D


7 6 5 4 3 2 1 0
R R R R: Read Only
1: Limit switch active
1: Limit switch error
0: reserved
1: Motor cable monitoring Off
0: reserved
1: Synchronization for parallel interface
1: parallel interface active
1: Test mode (reversing)

Remarks:

Bit 0 1: Activates the limit switch control

Bit 1 1: Limit switch error

Bit 2 1: If i^2t control has been used

Bit 3 1: The motor cable control can be switched off

Bit 4 0: Reserved

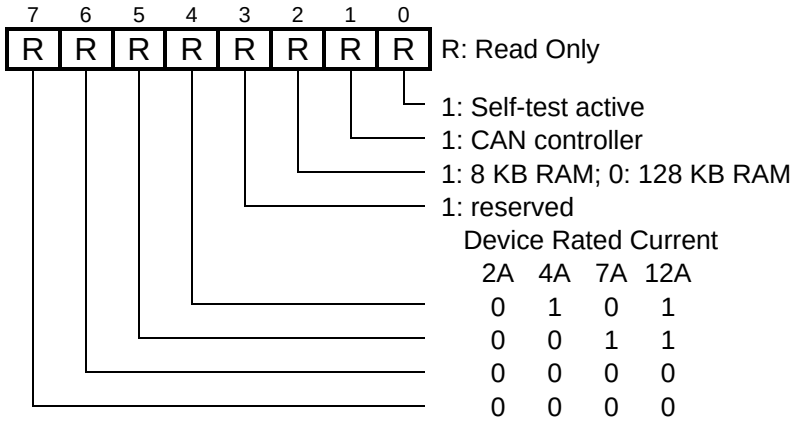
Bit 5 1: Activates the synchronization for the nominal-actual exchange through the parallel interface (special function)

Bit 6 1: Activates the parallel interface for the quick nominal-actual exchange

Bit 7 With 1 an internal test mode is switched on, so that ND31 reverses the motor with the set spin speed. This operating mode is especially useful in optimizing the regulator parameter.

12.3.2 The Byte HwVersion

RAM-Parameter Address: H' FE8B


7 6 5 4 3 2 1 0
R R R R R R R R
R: Read Only
1: Self-test active
1: CAN controller
1: 8 KB RAM; 0: 128 KB RAM
1: reserved
Device Rated Current
2A 4A 7A 12A
0 1 0 1
0 0 1 1
0 0 0 0
0 0 0 0

This is a read only byte.

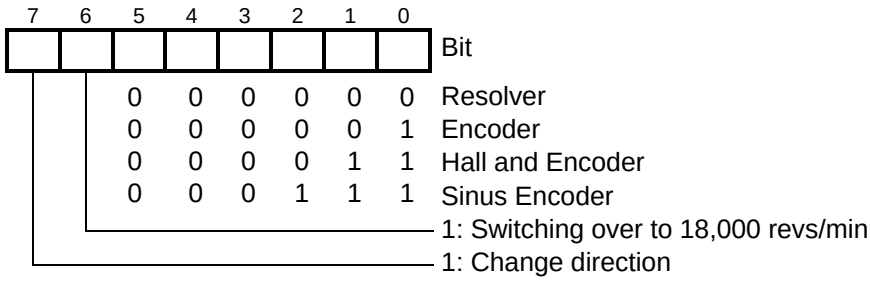
Remarks:

Bit 0	1: Self-test when switching on active
Bit 1	1: CAN-Controller available
Bit 2	1: 8 KB external RAM; 0: 128 KB external RAM
Bit 3	1: Reserved
Bit 4…7	Device rated current referring the above table

12.3.3 The Byte Feedback

RAM-Parameter Address: H' FF05

The byte can be read and written.


7 6 5 4 3 2 1 0
Bit
0 0 0 0 0 0 Resolver
0 0 0 0 0 1 Encoder
0 0 0 0 1 1 Hall and Encoder
0 0 0 1 1 1 Sinus Encoder
1: Switching over to 18,000 revs/min
1: Change direction

Remarks:

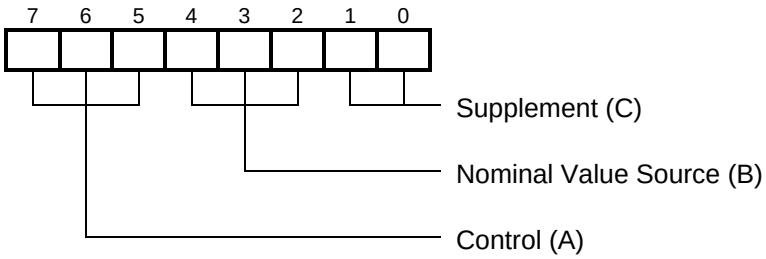
Bit 0…5	With these bits the feedback system can be programmed
Bit 6	Adjustment of the ND 31 speed range to 18000 rpm Afterwards the regulator parameter and the EMF has to be readjusted.

Bit 7 With this bit the spin direction of the motor can be changed. If the motor is supposed to be running in the positive direction, however is running negative, this can be corrected by changing Bit 3.

12.3.4 The Byte Betriebsart

RAM-Parameter Address: H' FF2A

The byte can be read and written.



With the byte "Betriebsart", the nominal value source and the size which has to be regulated, can be adjusted. For the effective use, a reset has to be released. By programming these bytes for a reset the corresponding pointers are set. If this is not required, please initialize the operation mode with H' FF. The following table shows that the bits 7,6 and 5 define the size (A), bits 4, 3 and 2 the nominal value source. The bits 1 and 0 contain additional information about the used feedback system.

Remarks:

	A	B	C	Size, Nominal Value Source, Feedback
	765	432	10	
Inertia	001	001	00	Inertia regulation, analogue input 1
	"	010	00	Inertia regulation, analogue input 2
	"	011	00	Inertia regulation, CAN
	"	100	00	Inertia regulation, digital
Speed Regulation	010	001	00	Spin speed regulation, analogue input 1
	"	010	00	Spin speed regulation, analogue input 2
	"	011	00	Spin speed regulation, CAN
	"	100	00	Spin speed regulation, digital
	"	101	00	Spin speed regulation, parallel interface
	011	001	00	Spin speed regulation with position regulator, analogue input 1
	"	010	00	Spin speed regulation with position regulator, analogue input 2
	"	011	00	Spin speed regulation with position regulator, CAN

	"	100	00	Spin speed regulation with position regulator, digital
	"	101	00	Spin speed regulation with position regulator, parallel interface
Postion Regulation	100	001	00	Position regulation, nominal value source through encoder
	"	010	00	Position regulation, nominal value source frequency/direction
	"	011	01	Position regulation, nominal value source NOVOBUS with standard feedback (resolver)
	"	„	10	Position regulation, nominal value source NOVOBUS with encoder as 2. system of measurement
	"	100	01	Position regulation, nominal value source CAN with standard feedback (resolver)
	"	100	10	Position regulation, nominal value source CAN with encoder as 2. system of measurement
Internal Vorgaben	"	101	01	Internal nominal value source (e.g. positioning) with standard feedback (resolver)
	"	101	10	Internal nominal value source (e.g. positioning) with encoder as 2. system of measurement
Test Mode	101	001	00	Test mode (reversing) without position regulator
	"	010	00	Test mode (reversing) with position regulator

12.3.5 The Byte MotConfig

RAM-Parameter Address: H' FF21

The byte can be read and written.

7	6	5	4	3	2	1	0	Bit
1	1	1	1	1	1	1	0	Motor temperature sensor with power connection (X1)
1	1	1	1	1	1	1	1	Motor temperature sensor connected in resolver connector (X2)

Remarks:

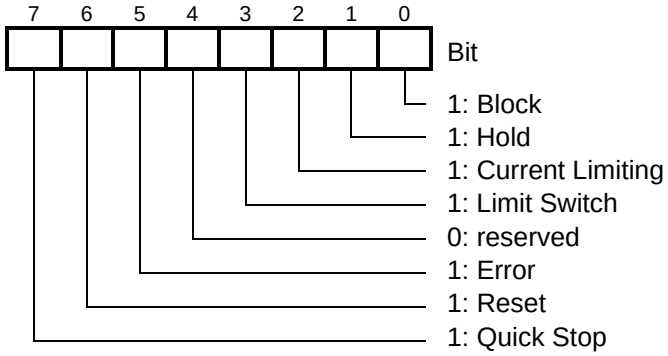
Bit 0	With bit 0 it is fixed, whether the motor temperature sensor is connected in connector X1 (Bit 0 = 0) or X2 (Bit 0 = 1).
Bit 1 … 7	Reserved 1

12.4 ND31 Status

12.4.1 The Byte Status

RAM cell address: H' FFF2

This is a read only byte.



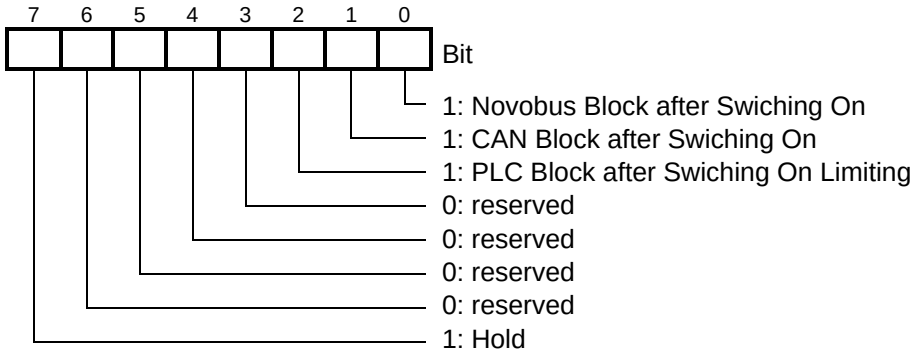
Remarks:

Bit 0	1: Drive blocked
Bit 1	1: Drive in hold mode
Bit 2	1: Current limiting active
Bit 3	1: Limit switch has been set
Bit 4	0: Reserved
Bit 5	1: Error
Bit 6	1: Drive in reset mode
Bit 7	1: Quick stop active

12.4.2 The Byte Freigabe0

RAM cell address: H' FF3C.

The byte can be read and written.



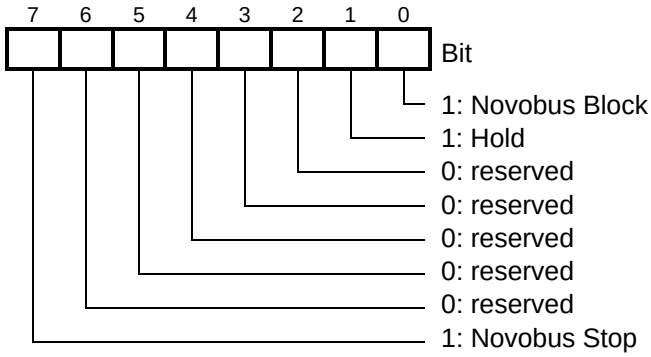
With the byte "Freigabe0" the start mode of the converter is programmed, that means the converter is in blocked or active mode. This byte will be evaluated after a Reset.

Exception: When working with the Setting Up Software the drive is blocked after a Reset.

12.4.3 The Byte NBcontrol

RAM cell address: H' FF52

The byte can be read and written.

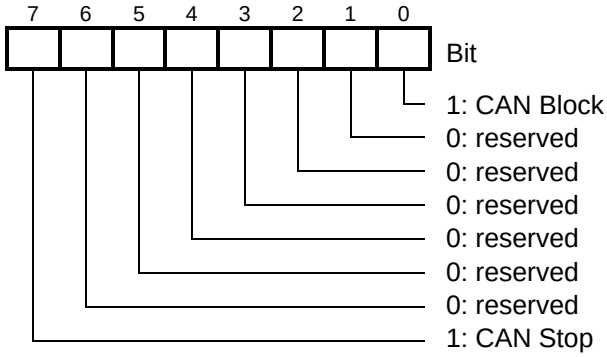


With byte "NBcontrol" the drive can be blocked and stopped via the NOVOBUS.

12.4.4 The Byte CANcontrol

RAM cell address: H' FFF3

The byte can be read and written.



With the byte CANcontrol the drive can be blocked and stopped via the CAN bus.

12.4.5 The Byte NB_Init

RAM cell address: H' FF04

The byte can be read and written.

With this byte the Baud rate of the NOVOBUS can be adjusted. At the moment 19200 and 38400 Baud are possible.

7	6	5	4	3	2	1	0	Bit
X	X	X	X	X	X	0	0	38,400 Baud
X	X	X	X	X	X	0	1	19,200 Baud

A change of the Baud rate will be effective after the first reset. Afterwards the Setting-Up software with the new Baud rate has to be started again as command line parameter (e.g.: ND31 19200).

12.5 Actual, Nominal and Limit Values

12.5.1 Current

12.5.1.1 Actual and Nominal Values

These values can only be read.

Motor current actual values: _iaist Address: H' F000
_ibist Address: H' F001

Scale	3202	3204	3207
A per bit	0.0589	0.206	0.206

Data format: Byte, two's complement

12.5.1.2 Limit Values

Rated current (effective): Imax Address: H' FE88 Byte

Scale	3202	3204	3207
Imax A_{eff} per bit	0.0345	0.1206	0.1206

This value will be adjusted at the factory and can not be changed by the client. Therewith the rated current of the device will be fixed. The scale depends from the capacity of the device.

Description	Parameter	Address	Format
Peak current:	mmax	H' FF35	Byte
Peak current:	mmax16	H' FF36	Word
Maximum for i^2t limit:	$i_0$max	H' FF2E	Byte

These value can be fixed by the user. The values are according to the motor which is supposed to be used (peak current and rated current). The current can be limited with mmax and mmax16. The smaller one determines the maximum peak current.

Scale	3202	3204	3207
mmax A_{eff} per bit	0.0345	0.1206	0.1206
$i_0$max A_{eff} per bit	0.0345	0.1206	0.1206
mmax16 A_{eff} per bit	0.000135	0.00047	0.00047

12.5.2 Torque

These values are read only bytes.

Torque nominal value: msoll Address: H' FE5E

Data format: Word, two's complement
Scale: See mmax16

12.5.3 Speed

12.5.3.1 Actual and Nominal Value

The value can only be read.

Speed actual value: nist Address: H' FE68
Speed nominal value: nsoll Address: H' FE62

Data format: Word, two's complement

Scale:

0.223517 rpm per bit, if bit 7 from Feedback = 0 (6,000 rpm)

0.894068 rpm per bit, if bit 7 from Feedback = 1 (18,000 rpm)

12.5.3.2 Limit Values

This value can be programmed by the user and depends of the motor which is supposed to be used.

Maximum speed: nMax Address: H' FEE4

Format: Word

Scale: See previous section.

12.5.4 Ramps

The ramps are to be programmed by the user. The quick-stop ramp will be used with a stop command (hard- or software).

Acceleration ramp:	Rampe	Address: H' FEFA
Braking ramp:	Rampe-	Address: H' FEFC
Quick-stop ramp:	SchRampe	Address: H' FEFE

Data format: Word

Scale: Ramp = 0.1466 ∗ n / t with [n] = rpm, [t] = s

Example: If the speed of 1000 rpm should be achieved in 10 ms, there is:
Ramp = 0.1466 ∗ 1000 / 0.01 = 14660 = H’ 3944

To use the programmed ramp, the pointer "?Rampe" (H' FEA8) has to direct to "Rampe" (H’ FEFA), "?Rampe-" (H’ FEAA) to "Rampe-" (H’ FEFC) and "?SchRampe" (H’ FEC4) to "SchRampe" (H’ FEFE).

12.5.5 Tracks

Nominal values can be programmed by the user.

Rotor position nominal value:	LageSoll	Address: H' FE54
Rotation nominal value:	UmdrSoll	Address: H' FE56
Rotor position actual value:	LageIst	Address: H' FE7C
Rotation actual value:	UmrdIst	Address: H' FE7E

Data format: **"**Umdrsoll" and "Lagesoll", as well as "Umdrist" and "Lageist" form a 32 bits Double Word in the two's complement.

12.6 Temperatures

12.6.1 Cooler Temperature

These values can only be read.

The limit value will be compared with the cooler temperature which will be measured at three places of the ND31. If the cooler temperature is higher than the programmed limit value, the power stage switches off with the error message H' 400.

Cooler temperature T0:	Temp0	Address H' FFF8
Cooler temperature T1:	Temp1	Address H' FFF9
Cooler temperature T2:	Temp2	Address H' FFFA
Cooler temperature T3:	Temp3	Address H' FFFB

Data format: Byte, no prefixes

Scale [°C]**:**

$$t1 = \frac{1}{\frac{\ln(\frac{56.32}{Temp0} - 0.1)}{3429} + \frac{1}{298}} - 272.5$$

12.6.2 Motor Temperature

The motor temperature actual value can only be read. The motor temperature limit value can be read and written.

Temperature threshold:	MaxTempMot	Address H' FF01
Motor temperature:	MotTemp	Address H' FF54

Data format: Byte, no sign

Scale: 1 Bit corresponds to 58.75 Ω

The motor temperature can be calculated by the characteristic of the built-in sensor of the motor. When using a motor with a normally closed contact enter the value H' FF in MaxTempMot.

12.7 Regulator Parameter

Every regulator parameter can be changed by the user.

12.7.1 Current Regulator

ND31 works with a PI current regulator

P component: ikp Address H' FEF8
I component: iki Address H' FEF9

Data format: Byte, no sign

12.7.2 EMF Compensation

The EMF compensation performs a pre-controlling of the voltage to compensate the counter EMF of the motor.

EMF compensation: emk0 Address H' FF03

Data format: Byte, no sign

Scale: emk0 = 2.75 V (voltage radiant of the motor in V/1000rpm)

12.7.3 Filter

12.7.3.1 Tacho Filter

With the tacho filter it is possible to filter the actual speed value. It is a filter of the first order. The higher the adjusted value, the stronger the filtration.

Tacho filter: nFilter Address H' FF3F

Data format: Byte, no sign; range: H' 00 ... H' 7F.

Scale: Time constant

$$\text{Tacho filter} = \frac{432\,\mu s}{1 - \frac{\text{nFilter}}{128}}$$

12.7.3.2 Nominal Value Filter

With the nominal value filter it is possible to filter the spin speed nominal value. The nominal value filter is a filter of the first order. The higher the adjusted value, the stronger the filtration.

Nominal value filter: nSollFilter Address H' FEF6

Data format: Byte, no sign; range: H' 00 ... H' 7F.

12.7.4 Speed Regulator

ND31 operates with a PI speed regulator with an advanced control.

P component:	nKp	Address H' FF32
I component:	nKi	Address H' FF33
Advanced control:	nKd	Address H' FF31

Data format: Byte, no sign; range: H' 00 ... H' 7F.

12.7.5 Position Regulator

ND31 works with a P position regulator with advanced control.

P component:	LKp	Address H' FF30
Advanced control:	LKd	Address H' FF2F

Data format: Byte, no sign; range: H' 00 ... H' 7F.

12.7.6 Resolver Adjustment

To achieve a correct commutation the resolver mounting position can be shifted electronically.

Resolver adjustment: PhiPo Address H' FEF0

Data format: Word

Scale: 1 bit means 1 increment

14.7.7. Motor Poles

It is possible to program the number of motor poles in the ND31 (2 ... 12).

Motor poles: Pole Address H' FEF7

Format: Byte, no sign; range: H' 02, H' 04, H' 06, H' 08, H' 0A, H' 0C

The new number of motor poles can only be activated after a reset.

12.8 Signal Inputs and Outputs

12.8.1 Digital Signals

Read Inputs

There are two ways to read the digital inputs of ND31:

Either by reading directly the below mentioned memory cells, or by setting an input word.

Table of the digital inputs of ND31:

Reading Directly

Digital Input	Memory Cell	Bit	Port	X3 Pin	0V =
GPIN1	H' FFBB	4	6	A34	"1"
GPIN2	H' FFBF	1	8	A24	"1"
GPIN3	H' FFBF	0	8	A27	"1"
GPIN4	H' FFBB	3	6	A25	"1"
GPIN5	H' C405	7	X	A26	"1"
GPIN6	H' FFB7	3	4	A21	"1"
GPIN7	H' FFB7	5	4	A23	"1"
GPIN8	H' FFBB	0	6	A32	"1"
GPIN9	H' FFBB	2	6	A33	"1"
GPIN10	H' FFB7	2	4	A22	"1"

Input Word

The input word GPIN (H' FE0C) contains the mode of the digital input and will be renewed every 1 ms.

GPIN: Address H' FE0C

Bit	15	14	13	12	11	10	9	8
	–	–	Tast5	Tast6	Tast7	Tast8	GPIN10	GPIN9
Bit	7	6	5	4	3	2	1	0
	GPIN8	GPIN7	GPIN6	GPIN5	GPIN4	GPIN3	GPIN2	GPIN1

Outputs

There are 2 ways to set the digital outputs of ND31:

1. By describing of the memory cells mentioned below. Here only the corresponding bit can be changed. The bits left have to retain their mode.
2. By setting an output word.

Table of the digital outputs of ND31:

Writing Directly

Digital Output	Memory Cell	Bit	Port	X3 Pin	Switching	0V =
GPO1	H' FFB7	6	4	B22	0 V	"0"
GPO2	H' FFB7	4	4	B21	0 V	"0"
GPO3	H' FFB7	1	4	B24	24 V	"0"
GPO4	H' FFBB	1	6	B28	24 V	"0"
GPO5	H' FFC1	2	9	B27	24 V	"0"
GPO6	H' FFBB	5	6	B26	24 V	"0"
GPO7	H' FFBB	6	6	B25	24 V	"0"
GPO8 *	H' FF84	0	–	B23	24 V	"0"
GPO9	H' FFC1	0	9	B30	24 V	"0"
GPO10	H' FFC1	1	9	B29	24 V	"0"

*: For using GPO8 as digital output bit 5 of InitIOM1 has to be set to 0.

The signal modes can be read in the corresponding memory cells.

Output Word

A much easier method to set the digital output is to describe an output word GPO (H' FE0A). The contents will be evaluated every 1 ms and the corresponding outputs will be set.

First the pointer ?GPO (H' FEC2) has to be directed to GPO (H' FE0A). The outputs GPO1 to GPO10 can be set by describing bit 0 to 9.

GPO: Address H' FE0A

Bit	15	14	13	12	11	10	9	8
	–	–	–	–	–	–	GPO10	GPO9
Bit	7	6	5	4	3	2	1	0
	GPO8	GPO7	GPO6	GPO5	GPO4	GPO3	GPO2	GPO1

Mask of the Outputs

For the digital outputs GPO1 to GPO8 are additionally one byte available to mask the outputs GPOMask (H' FEC7). If the bit is set in the mask (=1), the corresponding GPOs are unchanged, independent of what has been written in GPO.

GPOMask: Address H' FEC7

Bit	7	6	5	4	3	2	1	0
	GPO8	GPO7	GPO6	GPO5	GPO4	GPO3	GPO2	GPO1

12.8.2 Analogue Outputs

ATTENTION!	**The analogue outputs are not short-circuit proof and are only to be loaded with 5 mA at maximum.**

± 10 V 8 Bit or 16 Bit

With the ND31 two ± 10 V analogue outputs are available (resolution is 8 bits): at Pin A5 (analogue output 1) of connector X3 and at Pin B3 (analogue output 2). If you use the analogue outputs then GPO8 and GPO1 cannot be used as digital outputs.

The analogue outputs are configured using the AnOutConfig byte (H' FF20).

7	6	5	4	3	2	1	0	Bit
1	1	1	1	1	1	1	0	Analogue output 1 active
1	1	1	1	1	1	0	1	Analogue output 2 active
1	1	1	1	1	1	0	0	16 bits mode for analogue output 1

In the 16 bits mode the voltage is output with a resolution of 16 bits at analogue output 1 (X3, Pin A5).

Programming of the outputs: if the desired mode is determined (AnOutConfig) then the output may be programmed using the following bytes:

Analogue output 1	Signal selection	?AnOut1	Address: H' FF24	Word
	Offset	AnOutOffs	Address: H' FF26	Byte
	Scaling factor	AnOutFakt	Address: H' FF27	Byte
Analogue output 2	Signal selection	?AnOut2	Address: H' FF12	Word
	Offset	AnOut2Offs	Address: H' FF15	Byte
	Scaling factor	AnOut2Fakt	Address: H' FF14	Byte

Signal selection

The address of the desired signal has to be entered into "?AnOut1" ("?AnOut2"). If, e.g., the actual speed value (H' FE68) shall be output then the value H' FE68 has to be entered into "?AnOut1" ("?AnOut2").

Offset adjustment

Offset adjustment is carried out by entering a value between H' 01 and H' FF into "AnOutOffs" ("AnOut2Offs"), with H' 01…7F = positive Offset and H' FF…80 = negative Offset.

Scaling With "AnOutFakt" ("AnOut2Fakt") the scaling factor may be adjusted (also inverting the voltage).

Reset In order the programming to become effective a Reset must be carried out.

12.8.3 Encoder Emulation

Pulse number of the encoder emulation:	Impulszahl	Address: H' FEF4

Data format: Word

Range: H' 0001 ... H' 0400

A changed pulse number becomes effective after a Reset.

12.9 Drive Info

12.9.1 Serial Number

The serial number can be inferred from the memory cells H' FE84 to H' FE86 ("Seriennummer").

Serial number	Seriennummer	Address: H' FE84

Data format: BCD, MSB = H' FE84

12.9.2 Operating Hours

The operating hours can be inferred from the memory cells H' FE92 to H' FE97. it is differentiated between active time (power stage enabled) and the passive time.

Active time	BetriebStd	Address: H' FE92
	BetriebMin	Address: H' FE96
Off period	SperreStd	Address: H' FE94
	SperreMin	Address: H' FE97

Data format: Hours: Word
Minutes: Byte

12.10 Controlling the ND31 via NOVOBUS

With the exception of some special commands like Reset, controlling functions by reading or writing of RAM cells of the

µController H8, thus influencing control bytes and getting information by reading of status bytes.

12.10.1 Operating States

Lock:	Setting Bit **0** of "Status" (H' FFF2) to 1
Release:	Setting Bit **0** of "Status" to 0
Stop:	Setting Bit **7** of "Status" to 1
Cancel Stop:	Setting Bit **7** of "Status" to 0

Reading the "Status" byte informs about the present operating state.

12.10.2 Error Condition

An error is indicated by Bit **5** of "Status" (H' FFF2) set to 1. The error code may be taken from the address "errorcode" (H' FE00). The error is acknowledged by writing H' AF00 into the address "errorcode".

Query error state:	Reading Bit **5** of "Status" (H' FFF2)
Error code:	"errorcode": address H' FE00
Data format:	Word
Acknowledge error:	Writing H' AF00 into RAM cell "errorcode" (H' FE00)

12.11 Oscilloscope

12.11.1 Signal Selection

All signals residing in the RAM may be selected by writing the appropriate code into the following memory cells:

Signal 1 = 'scope_signal1': H' FE04
Signal 2 = 'scope_signal2': H' FE06
Trigger signal = 'scope_trigger': H'FE08

Example: H' FE68 → H' FE04 ⇒ Signal 1 = actual speed value (RAM cell H' FE68)

For displaying only 1 signal the "scope_signal1" and "scope_signal2" parameters must contain the same address.

The contents of the selected memory cells are recorded. The meaning and scaling of the record is determined by the signals

specified. If a 16-bit value is selected as signal then the upper byte (MSB) is recorded only.

Example: If H' FE68 is entered into RAM cell H' FE04 as Signal 1 this means:
actual speed value ("nist"),
scaling: 0.223517 revs/min per bit

A recorded value of, e.g., H' 4C corresponds to a speed value of
0.223517 ∗ H' 4C ∗ 256 = 4348 revs/min.

For signal selection recording must be inhibited.

12.11.2 Time Base

The scan rate of the storage oscilloscope is to be entered into RAM cell "scope_timer" (H' FF7C). Storing of a new measuring value occurs each scan time period:

$$t_{scan} = \text{scope\_timer} * 512\ \mu s$$

A total of 128 measuring values are read per channel.

Example: scope_timer = 0 ⇒ each 512 µs one measuring value will be stored in the scope buffer. The full scope buffer then is 128 x 512 µs = 65.536 ms wide.

scope_timer = H' 05 ⇒ each 5 x 512 µs (= 2.56 ms) one measuring value will be stored in the scope buffer. The full scope buffer then is 128 x 2.56 ms = 327.68 ms wide.

For adjusting the time base recording must be inhibited.

12.11.3 Triggering Threshold

Die triggering threshold is to be entered into RAM cell "scope_level" (H' FF7F) with Bit 7 inverted.

Example: "nist" (H' FE68) shall be triggered for 4000 revs/min ⇒
4000 / 0.223517 = 17895 = H' 45E7;
MSB only: H' 45;
Bit 7 inverted: H' C5;
H' C5→ scope_level (H' FF7F)

The triggering threshold can changed any time.

12.11.4 Trigger Delay

The trigger delay requires programming of the two RAM cells "scope_delay" (H' FF7D) and "scope_counter" (H' FE02) each

time before beginning a new record procedure. The values are calculated as follows:

For the desired delay time t_{delay}:

scope_counter = H' 0100 + t_{delay}/t_{scan} (t_{scan} = time base)

scope_delay = H' 00 for $t_{delay} \geq 0$ or

= $-t_{delay}/t_{scan}$ for $t_{delay} < 0$

Example: t_{scan} = 1.024 ms (scope_timer =2), t_{delay} = -20 ms ⇒ 19 (= 20 ms /1.024 ms = 19.53) scanning spots shall be recorded before the trigger time and 237 scanning spots after it
scope_delay = 19 = H' 13,
scope_counter = H' 0100 - H' 13 = H' 00ED

12.11.5 Scope Status

The "scope_status" byte (H' FF7A) controls recording.

Bit 7:	Shows the status of the oscilloscope: 0: recording active 1: recording inhibited
Bit 6:	Shows the trigger status: 0: no trigger 1: triggered
Bit 5:	Trigger status, initialized with 1
Bit 4:	Trigger edge
Bit 3…0	reserved (= 0)

Bit 7 is automatically set to 0 at the end of the recording procedure. A recording procedure may also be stopped by setting Bit 7 to 0.

12.11.6 Recording Procedure

When recording is stopped programme
- "scope_delay" and "scope_counter" with the necessary values
- "scope_status" with H' 20 for a negative triggering edge or with H' 30 for a positive triggering edge.

With that recording is started.

First the delay time expires.

Then the trigger condition is evaluated ("scope_status" byte):

Bit 5 is switched to 0 as soon as the signal
- falls below the triggering threshold for a positive triggering edge or
- exceeds the triggering threshold for a negative triggering edge.

Bit 5 is set to 1 again as soon as the triggering threshold is passed through once again thus generating the trigger signal: Bit 6 is set to 1.

After triggering the time programmed in "scope_counter" expires. Then recording is stopped automatically and Bit 7 is set to 1.

The recorded data are now available in the 256 bytes FIFO memory of the scope ("_FIFOdat": H' FF83). Each one date (byte) is read per read access. Thus, 256 read accesses to the _FIFOdat address will empty the scope memory. The data of Signal1 and Signal2 are output alternately.

12.11.7 Auto Trigger

Recording without trigger is possible if Bit 7 of "scope_status" is set to 0 during the recording procedure and, afterwards, set to 1 again.

12.12 Resolver Auto Adjustment

ND31 offers the possibility of establishing the resolver adjustment automatically. This is useful if an unknown motor shall be installed with the ND31.

Conditions:

- Pole number and phase position of the motor are known.
- Current and speed regulators must swing.
- The intermediate circuit is loaded and the hardware signals Enable and Start are present.

Procedure:

Enter the value H' 80 into the control byte "RautojuCSR" (H' FE6E).

Now the power stage is enabled automatically and a DC current is supplied to the motor. The motor goes into a privileged position. After 10 seconds the position is measured and the resolver angle is calculated from this. This value is directly entered into "PhiPo" (H' FEF0).

The function is terminated when "RautojuCSR" = 0.

12.13 Brake Function

For special applications, it may be useful that the stop brake is applied before the drive is locked (typical of vertical axes). By analogy with this, the brake should be released after the enabling the drive. ND31 supports this function. The hardware signal for

controlling the braking relay is the digital output GPO3 (Connector X3, Pin B24).

The desired delay times may be entered at addresses "BremseT1" (H' FEB4) and "BremseT2" (H' FEB5).

"BremseT1" determines how many 10 ms cycles shall pass after enabling the drive before releasing the brake, i.e., GPO3 switches to 1 (24 V). The function is deactivated with "BremseT1" = H' FF.

"BremseT2" determines the delay time in 10 ms cycles for the software lock (delayed switching of GPO3 to 0 V).

This function becomes only effective after a Reset.